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S14.6. Social media and new information flows: effects on innovation

Social Media, Reputation And Branding Of Innovation Hubs: A Periscope Using Content Analysis Of Twitter

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2. **Title:**
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4. Keywords:
Innovation, information, Twitter, city, reputation

5. Abstract:
Whether and how the reputation, branding or perception of a city is associated with innovation can have a powerful impact on the flows of resources to, from and within the region. The paper complements the traditional rank about innovation hubs with a study of cities' innovation reputation. The study uses the Innovation Tweet Dataset to study the conversations about innovation and cities on Twitter. Key factors in the messages for building innovation reputation are identified via the visualization tool Wordle. A synergic model is proposed and insights are provided for marketers, communicators and city developers to improve the perception of cities' reputations for innovation and to use social media to manage the brand of the city.

6. Introduction:

Cities are hubs for regional innovation. They are home to the organizations that produce the intellectual property, to the businesses that produce the new products and services, and to the people who power the organizations and businesses. Over recent decades, academic literature on economic development has focused increasingly on innovation as the key to the long-term competitiveness in a global business environments and has drawn attention to the role of technological change as an endogenous factor in growth (Marceau, 2008).

Cities have reputations, and these reputations become their brands. Reputation is an intangible resource leading to sustained competitive advantage (Barney, 1991; Dierickx & Cool, 1989), related to social standing (Fombrun & Shanley, 1990). Reputation is "the distribution of cognitive, representations that members of a collectivity hold (Basdeo, Smith, Grimm, Rindova & Derfus, 2006)" about a target (Luoma-aho & Nordfors, 2009). Higher prices, cheaper supplies, satisfied personnel, lower risk of crises, better recruits and lower transaction costs top the list (Fombrun, 1996). Whether and how the reputation, branding or perception of a city is associated with innovation can have a powerful impact on the flows of resources to, from and within the region. For example, Innovation Taskforce recommends the Ireland government reinforce Ireland's reputation through a consistent focus on the pathway to economic recovery based on the Smart Economy concept and re-branding as the Innovation Island in order to achieve the government's vision for Ireland to be an international innovation hub (Innovation Taskforce, 2010). The rise in the number of cities calling themselves "innovative cities" also reflects attempts to build these reputations.

Silicon Valley has had a reputation as home of high-tech business and innovators for decades. Cities in the Valley attract researchers, innovators, entrepreneurs, and investors. Around the world and especially within the Triple Helix communities, people ask the question, "which city will be the next Silicon Valley" as many cities are trying to re-model themselves as Silicon Valley – like innovation hubs. However, innovation need not simply mean new technologies or inventions. Paul Romer, a thought leader on the economics of innovation, points out that it simply means discovering better ways to do things, whether low-tech or high-tech (Standage, 2010). In this context, we ask several questions about innovation and reputation. How can cities be compared on their reputations for innovation? Can media be used to detect a new innovation hub as it begins its ascent? How can a city's reputation as an "innovative city" be developed?

Traditional measurements of innovation, such as number of patents, investments in research and development and the emergence of new job categories have been used to detect and forecast the rise of new innovation hubs and their cities. For example, in a recent study about the most innovative cities of America, the metrics included: number of patents per capita, amount of venture capital investment per capita, and ratio of high-tech, science and "creative" jobs (Greenberg, 2010). More detailed approaches to ranking the innovativeness of the city have been proposed. 2thinknow has announced a top 100 innovative city ranking in their Innovation Cities™ Program (www.innovation-

cities.com). The program uses benchmarking data as the basis, a 3-factor, Cultural Assets, Human Infrastructure and Networked Markets, ranking of 256+ cities actual performance on innovation (2thinknow, 2010). The program uses a 162 indicator framework, based on which it then uses the classification of nexus, hub, node, influencer, or upstart, claiming to present a new and innovative way of considering innovation clusters and regions (2thinknow, 2010).

This study complements the Innovative Cities™ Program with a study about cities' innovation reputation. In this study we ask: Which cities have the greatest visibility in the social media, Twitter? What themes/memes are associated with innovation? What are the Keywords, hashtags, and URLs for innovation that is shared most frequently in social media?

7. Methodology:

It has been suggested that we are moving away from a competitive market towards a reputation society (Luoma-aho, 2005). Pizzorno (2004) points out that in a reputation society, there is a special emphasis on social networks. With an entire 140-charater message and attached URLs, people use the Twitter platform to express and share thoughts and ideas with others in the network in real time. Many elected officials have been relatively quick to pounce upon the power of social media as a communications tool (Johnstone, 2010). Many of them tweet on Twitter regularly (Rosica, 2009). Although there still exist many concerns about the potential for public criticism, legal issues, workload, etc., some city governments are officially adopting social media to reach their citizens. The City of Philadelphia's Assistant Managing Director, Jeff Friedman, thinks that the value of social media for the government is being able to reach many people at one time at zero cost (Johnstone, 2010).

Within a single 140-charater message in which URLs are embedded, people use the Twitter platform to express and share thoughts and ideas with others in the Twitter network in real time. Features of tweets such as using "@", hashtag, Re-Tweet and other conversational conventions enable communication among people, similar to a group conversation, without geographical limitations. "@" plus a twitter handle is used when people want to include someone specifically in the conversation. For example, person A tweets a message and @ person B in it. When B is on twitter, those tweets with @ B's name get his attention immediately. B can reply to A by sending another tweet and @ person A in the message. Thus starts the conversation. Re-Tweet is to post a copy of someone else's tweet on your own account (Chucklyn, 2008). With the words of "RT" in the tweet, you are telling your followers that this is something you found interesting or worthy of checking out from someone else. The number of Re-Tweet messages is an important metric to measure how many people have shared the message. It's a useful benchmark to access the reach of one tweet. Quite often, if one wants to spread one tweet widely, he explicitly encourages participants to Re-Tweet directly with the "please Re-Tweet" in the message. The "#" symbol, called a hashtag, is used to mark keywords or topics in a Tweet (support.twitter.com). Twitter users use it to categorize messages use it. Each hashtag represents one general topic. Quite often, a conference or event organizer provides a specific hashtag for attendees to tweet. If everyone agrees to append a certain

hashtag to tweet about one topic, it becomes easier to find the topic and more likely, the topic will appear in Twitter's Trending Topics (Parr, 2009).

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On the other hand, the amount of data available on the site and its easily searchable nature makes Twitter has become a great platform for data-mining and information gathering (Darknet, 2009). Twitter conveys meaningful information about a given domain within 140 characters or less. Wagner and Strohmaier (2010) introduces a network-theoretic model of social awareness stream, a so-called "tweetonomy", together with a set of stream-based measures that allow researchers to systematically define and compare different stream aggregations. They apply the model and measures to a dataset acquired from Twitter to study emerging semantics in selected streams. Researchers at Stanford University has done a semantic analysis of energy-related conversations on Twitter, exploring whether and to what extent Twitter act as a useful tool for tracking conversations related to energy consumption (Russell, Flora, Strohmaier et al., 2011).

Hence, this study collects data from Twitter to assess the reputation of a city through people's online comments. The approach leverages the global nature of social media and the speed with which users have extended Twitter's platform points to a larger truth about modern innovation (Johnson, 2009). The study uses the Innovation Tweets Dataset (Rubens, Yu, Louvigne & Russell, 2011), which was constructed by utilizing the TwitterStreamer (Louvigne et al., 2011) to capture tweets containing terms "innovation" and "innovative" from March 9 to May 31 in 2011. With a reference to the Innovation Cities™ Program, the top 20 cities on the list are selected. These 20 cities' names (New York) or abbreviation names (NY) further filter the Twitter messages gathered in Innovation Tweets Dataset. The selected Tweets were counted and analyzed for each city.

In the analysis the focus is content. The traditional content analysis methods used to establish the frequency of terms in text can be constrained by human limitations – most notably the difficulties inherent in selecting terms to measure from a large collection of documents (Dick, 2011). Historian Alfred Crosby (1997) has applauded the power of visualization and measurement as the two main factors enabling the explosive development of modern science. The underlying objective of information visualization is to amplify the cognition of a user through an expressive, often interactive view that gives insight on a given phenomena represented by the data (Ware, 2004). In this paper, a visualization tool called Wordle is used for content analysis of the Tweets. Wordle is a web browser based tool for generating "word clouds" from text that user provides. Wordle uses computational algorithms to analyze textual content and generate "tag

clouds" in which the size of the word is proportional to the frequency with which it appears in the text. Tag clouds give greater prominence to words that appear more frequently in the source text (www.wordle.net). In order to have a better visualization, the words of "innovation" "innovative", "the name of the city e.g. New York" and "rt" have been removed from the cloud.

Wordle has been used to analyze partisanship framing in political speeches (Monroe et al., 2008) and content analysis about the language of newspaper (Dick, 2011), etc. McNaught (2010) demonstrated that Wordle can be used as a supplemental research tool for preliminary analysis, highlighting main differences and possible points of interest. Additionally, Wordle is suggested as a validation tool to further confirm findings and interpretations of findings. Tag clouds, also known as word clouds, thus provide additional support for other analytic tools.

8. Findings and Interpretation

Between Mar 9 and May 31 in 2011, the Innovation Tweets Dataset (Rubens, Yu, Louvigne & Russell, 2011) captured tweets containing terms "innovation" and "innovative" close to 1 million tweets (976,775). Tweets that included the name or abbreviation of each city were gathered and counted for each city. The number of innovation Tweets is shown in Table 1 for each of the top 20 cities listed in the Innovation ranking order used by 2thinknow. The highlighted cities appeared in over 1,000 innovation Tweets in 12 weeks. The numbers show that the top three cities with most innovation Tweets are London (4,177), New York City (4,151) and Boston (3,688).

The Innovation Tweet rank is not consistent with the rank in the Innovation Cities™ Program. In particular, some European cities, which rank high in the Innovation Cities™ Program, are not visible in Twitter conversations related on innovation. Two explanations may account for this. Firstly, the smaller number of Innovation Tweets about European cities may be due to the differing Twitter adoption cycles. Twitter started in US; the user interface was initially English only. People who speak English as their first language may use Twitter more than people who speak other languages or for whom English is a second language. Those whose native language is not English may use some similar platforms other than Twitter to communicate. Secondly, the data was gathered by using the English words of "innovation" and "innovative". People in European countries may tweet about innovation by using local language such as French, German, etc. This rationale can be applied to some of the Asian countries in the list as well.

Table 1. Comparison of Ranks: Innovation Tweets (Showing Number of Tweets in 12 Week Period) V.S. Innovation Cities™ Program ,
(Difference = Innovation Cities™ Program Rank - Innovation Cities # of Tweets Rank)

Innovation Tweets Rank	**Innovation Cities TM Program**	**Country**	**# of Tweets (Mar. 9 to May 31, 2011)**	**Innovation Cities™ Program Rank**	**Difference**
1	London	U.K.	4,177	14	13
2	New York	U.S.	4,151	5	3
3	Boston	U.S.	3,688	1	-2
4	Paris	France	2,027	2	-2
5	San Francisco	U.S.	1,792	7	2
6	Toronto	Canada	1,747	12	6
7	Lyon	France	923	9	2
8	Berlin	Germany	746	11	3
9	Milan	Italy	683	16	7
10	Tokyo	Japan	584	20	10
11	Amsterdam	Netherlands	484	3	-8
12	Melbourne	Australia	403	19	7
13	Stockholm	Sweden	282	17	4
14	Hamburg	Germany	251	10	-4
15	Vienna	Austria	210	4	-11
16	Munich	Germany	192	15	-1
17	Frankfurt	Germany	179	6	-11
18	Copenhagen	Denmark	124	8	-10
19	Hong Kong	Hong Kong	89	18	-1
20	Stuttgart	Germany	53	13	-7

In the Wordle analysis of the Twitter messages, conducted for each of these 20 cities to ascertain the content of the Tweets and the semantics of innovation, the most frequently mentioned words among conversations on Twitter could be identified. Some common keywords and topics related with innovations are seen across three countries, for example, business, jobs, marketing, technology, social, and entrepreneurship, etc. More often, each city was characterized with unique words, hashtags and URLs that are specific to the context of innovation in that city. To understand some terms, url links were followed; and some explanations are provided as reference in this paper.

8.1. London:

Figure 1. Wordle word cloud of Tweets about Innovation/Innovative of London.

Business, marketing and jobs are frequently mentioned words when people talk about innovation in London. "Conference", "summit" and hashtags with abbreviation names of the events was the main driver for the conversations in these 12 weeks.

Table 2. Examples of Tweets of Innovative Events in London.

Key Words	# of Tweets (including RT)	# of RT	Examples of Tweets
Conference	150	55	• *Innovation in Comms Conference in Milan & Soho Hotel in London on 26th May.Cocktails &Communications..always a gr8 combo http://ow.ly/50vA3* • *Innovation Healthcare at ExCel, London had over 5000 vistors over 2 days for the conference and exhibition. We... http://fb.me/V2TpGNn2*
Summit	79	32	• *@David_Bott, Director of Innovation Programmes @Innovate_UK will be @WeOwnItSummit 9-10 June in London http://bit.ly/iA3tup* • *London Business School Global Leadership Summit: Social Innovation: Corporates Profit From Doing Good http://ow.ly/538be via @wsj #GLS2011*
Expo	22	15	• *End of a busy 1st day at NHS Health Innovation Expo in London -- lots of interest but plenty of handouts left for tomorrow! Sore feet! #ihi* • *DIGITAL EVENT from Digital Ministry - The Marketing Innovation Expo - London*
#QConLondon[1]	61	27	• *Patrick Copeland up talking about innovation at Google #qcon #qconlondon http://twitpic.com/482mgo* • *Innovation is the intersection of vision and hallucination. @copelandpatrick at #qcon #qconLondon* • *RT @timanderson Google has over 100,000 innovation ideas from employees in a database #qconlondon #li*
#GLS2011[2]	164	85	• *Rt Hon Dr. Vince Cable MP Secretary of State for Business, Innovation and Skills to deliver keynote address at #GLS2011* • *Phillip Cullimore Managing Director & Chairman of Eastman Kodak Sarl will discuss how to set the scene for innovation at #GLS2011.* • *Lookking fwd to Monday! RT @londonbschool: Phillip Cullimore, Chairman of Eastman Kodak Sarl, will discuss innovation at #GLS2011.*

Similarly, many tweets related to innovation awards were tweeted and widely Re-Tweeted by the people too.

- *Jamie Byng presenting Library Innovation of the Year, winner is: London Borough of Hillingdon Libraries #bia11*

[1] #QConLondon represents the fifth annual London enterprise software development conference designed for team leads, architects and project management. The event in the UK is an opportunity for learning, networking, and tracking innovation occurring in the Java, .NET, Ruby, SOA, Agile, and architecture communities. (www.qconlondon.com)

[2] #GLS2011 represents Global Leadership Summit, 'Innovation: Idea, Create and Accelerate'. It is hosted by London Business School on May 23, 2011. (www.london.edu)

- *Barclays Cycle Hire wins most Innovative Transport Project at the London Transport Awards! Thank you for your support! #borisbike #cyclehire*

In addition, from the tag cloud, @londonbschool and @thebeatgeeks stand out. They represent London Business School and The Beat Geeks band respectively related to business, marketing and music.
Twitter messages announce the innovation events or awards in London, build the reputation of the city of London as an innovative hub as well as promote the organizations or the brands that participate in the events or win the awards as innovative brands.

8.2. New York:

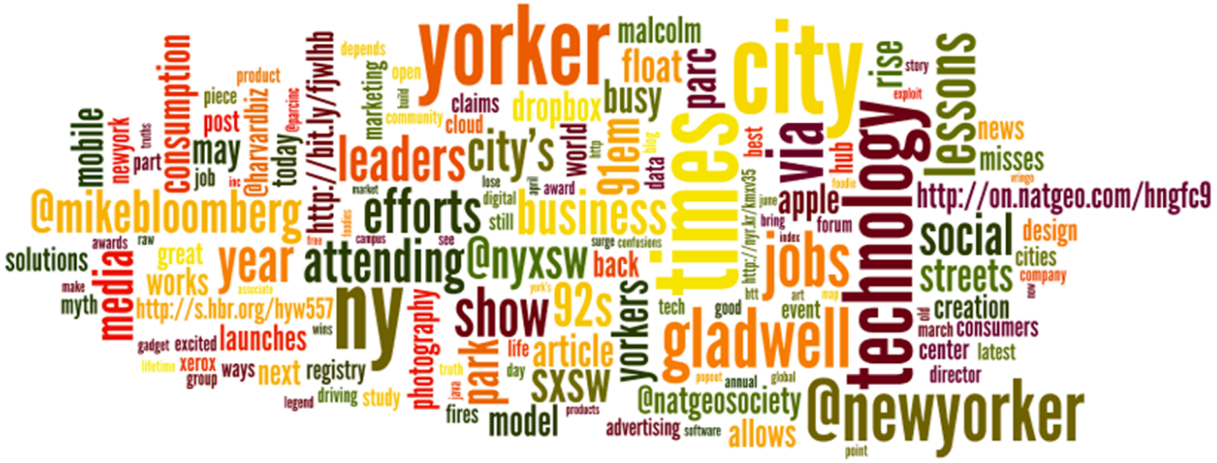

Figure 2. Wordle word cloud of Tweets about Innovation/Innovative of New York.

From the word cloud, it is visually apparent that the innovative social conversation about New York weighs more on technology than on business. Furthermore, the names of people or press' have strong visibility, namely, Malcolm, Gladwell, @mikebloomberg, @nyxsw, @newyorker, @harvardbiz, and @natgeosociety. Many of these are authorities or key opinion leaders. Apart from Twitter, they have already gained a reputation and have followers or readers who view them as opinion leaders. These entities lend credibility to the reputation of content of news or reports. People trust the resource, so their tweets have been widely Re-Tweeted. These opinion leaders are important promoters for a city's innovative reputation.

One example is Mike Bloomberg, an entrepreneur, mayor of New York City and philanthropist as self-reported in the identity statement of his Twitter account. On March 12, he tweeted,

> *"To all the NYC technology leaders attending #SXSW this year: show 'em how we do innovation here in #NYC @NYxSW".*

The tweet well expressed the mayor's pride in New York City Innovation. His call to action was Re-Tweeted 167 times in the next three days. People also responded emotionally to the Tweet:

- CeaseTheDay, 3/12/11, "*boom!! RT @MikeBloomberg To all the NYC technology leaders attending #SXSW this year: show 'em how we do innovation here in #NYC @NYxSW #fb"*
- AlexCapecelatro, 3/12/11, *"Awesome tweet: @MikeBloomberg All the NYC technology leaders attending #SXSW this year: show 'em how we do innovation here in #NYC @NYxSW"*
- MarkKrassner, 3/13/11, "*NYC! RT @mikebloomberg To all the NYC technology leaders attending #SXSW this year: show 'em how we do innovation here in #NYC @NYxSW"*
- Vsonsev, 3/13/11, "*love this. RT @cdixon @MikeBloomberg To all the NYC technology leaders attending #SXSW this year: show 'em how we do innovation here in #NYC"*
- IanGertler, 3/15/11, "*As a former NYer in mktg, #sm & tech - love this! MT @MikeBloomberg To #NYC tech leaders @ #SXSW: show 'em how we do #innovation here @NYxSW"*

8.3. Boston:

Figure 3. Wordle word cloud of Tweets about Innovation/Innovative of Boston.

The word cloud of Boston innovation Tweets also shows words reflecting a business orientation - economy, technology, marketing, etc. In contrast to New York or London, the Boston tag cloud includes many composite words with "boston" within them, such as "bostonredevelop", "@idboston", "boston.com", "@bostonupdate", "bostontweet", "bostinnovation". Most of these hashtags are related either to large organizations or to Boston local press. People are consciously Tweeting about innovation-related events in the Boston area.

Table 3. Boston Main Tweet Handles:

Tweet Handles	**Name**	**Short Description**	**Example of Innovative Tweets about Boston**
@BostonRedevelop	BRA	The Boston Redevelopment Authority (BRA) is the City of Boston's planning, economic development & workforce development agency. http://www.cityofboston.gov/bra	*Mayor Menino Welcomed New Companies to Boston's Innovation District http://ht.ly/4vxE8*
@IDBoston	Innovation Disctrict	Updates and discussion about Boston's Innovation District in the South Boston waterfront. Make history here. http://www.innovationdistrict.org	*"Green is the next frontier for Boston's Future" http://ow.ly/4uz3T #Innovation*
@BostonUpdate	Boston.com	Our top stories of the day, from the editors of Boston.com and the Boston Globe. http://boston.com	*How you build #innovation: Four CEOs reveal their secrets http://t.co/qRz04JM #globe100*
@BostInnovation	BostInnovation	The community platform for what's new in Boston business and beyond. For more, Like us on Facebook: at facebook.com/BostInno http://www.bostinnovation.com	*Innovation in Boston: Week in Review - http://eepurl.com/dI28-/*

In contrast to the content for other cities, the words "Harvard," "Cambridge" and "Research" show up in the word cloud, too, reflecting visibility of the academic and research drivers for Boston as an innovation hub.

- *Boston: City approves $20M Harvard Innovation Lab project in Allston: (Courtesy: Boston Redevelopment Authority)A... http://bo.st/fhHMJw*
- *RT @PBLN: #MAIP @MassGovernor Deval Patrick doing town meeting @Cambridge University, UK abt the MA innovation economy & cross-ocean par ...*

8.4. A Synergy Model

This preliminary analysis of a sample of cities suggests opportunities in the use of Twitter to better understand the reputation and branding of cities as innovation hubs. Based on the analysis of leading innovative cities, London, New York and Boston, a preliminary model can be proposed as a means to categorize and conceptualize the use and meaning of Twitter for reputation and branding of innovation of cities.

Figure 4. A synergy model of building the innovation reputation of a city on Twitter

Innovators are likely to gather together for exchanging new ideas and seeking for opportunities to collaborate with each other; brands/companies are introducing new concepts and launching their innovative products regularly big meeting; press are writing comments about the new city policy to encourage the innovation; etc. These are all very good content to be tweeted on the platform to build the innovation reputation about the city. From the examples of Tweets by New York City mayor and many Boston city organizations, the consciousness of city developers to build an innovation reputation about the city is on the horizon.

8.5. Lessons from Brand/Political Reputation Management

It is interesting to note that several strong brands appeared in the "innovation" or "innovative" Tweets selected for this study. In this preliminary analysis, some brands that are usually viewed with innovative products or services can be seen in the tag cloud too, such as Google, Dropbox, Xerox PARC, Apple, etc. These product and service brands were often mentioned in conjunction with an introduction or a review about new innovative products, services or business models.

- *The Google Metamorphosis – From Innovation to Entrepreneurship* *http://t.co/lZMBuft*

- *Google has over 100,000 innovation ideas from employees in a database #qconlondon*
- *Interesting take from @thenewyorker James Surowiecki: Dropbox, a model of innovative consumption. http://j.mp/mjoa8A*
- *The New Yorker [Gladwell]: Creation Myth: Xerox PARC, Apple, and the truth about innovation - http://tinyurl.com/6g84ul5*
- *Xerox PARC, Apple...Creation of the Mous: The New Yorker http://t.co/2QWMpxA - Gladwell's narrative on the messy business of innovation*

One can recognize via the link in the last two Tweets above that the Tweet is related to Malcolm Gladwell's article *Creation Myth – Xerox PARC, Apple, and the truth about innovation* in The New Yorker on May 16th. This Tweet can be viewed as an example of best practice in Tweeting. It brings together three factors: an influential innovative writer, a credentialed publisher and several well-known innovative brands. The combination of these factors together in one Tweet is notable – likely to generate clickthroughs and Re-Tweets. But interestingly, this Tweet is the beginning of a dynamic conversation. In response, PARC fires back at The New Yorker, claiming old apple legend misses point of how innovation works today. And this topic again generated a volley of Tweets and Re-Tweets on the social platform.

The application of this example to the reputation of a city lies in the construction of an influential Tweet and its viral impact within a community by combining two or more elements in the synergy model. This is instructive in its lessons for city reputation management. The Tweet creates viral effects by combining two or more factors in the framework above rather than only using one. For example, an opinion leader tweets about an event hosted by an innovative brand; a city organization tweets about a new finding from a famous innovative research lab; a governor tweets about a new policy within the city organization, etc.

In addition to strategic construction of Twitter messages, it's also important to emphasize the value of monitoring social conversations about an innovation hub, in this case defined by cities, in order to make timely and effective responses to accentuate the positive and redirect the negative points of views. Social media as an open platform offers unique capabilities for building awareness and shaping opinion; and also creates a high level of noise by the sheer size of content that is created by day, by hour or even by the minute (Kealey, 2009). It requires continual interaction. Unlike the monologue of broadcast messages, social media is a many-ways communication tool; it must be leveraged as such.

9. Conclusions:

Cities are hubs for regional innovation. Since we are moving towards a reputation society (Luoma-aho, 2005), there is a special emphasis on social networks (Pizzorno, 2004). This study analyzed Twitter collected for 12 weeks to assess the innovation reputation of a city. Close to one million Tweets (976,775) were collected with the keywords of "innovation" or "innovative" mentioned within the 140 characters of these Tweets.

With a reference of top 20 innovative cities in Innovation Cities™ Program, the number of Tweets mentioned about these cities has been compared to three top cities: London, New York and Boston. Additionally, word clouds were generated for each of the three cities for a further study of the content in these tweets. In addition to some common words such as "technology", "entrepreneurs", etc. related with all three cities, unique keywords in the conversations about each city were identified. By tracing back to the Tweets with these unique keywords in the dataset, the study unveiled the innovative happenings, hot topics and key players in each city. Furthermore, it was noted that the conversations in each city were driven by different factors, which can be categorized to three main groups: "events," "organization" and "opinion leaders." Hence, a synergy model based on the study is proposed. Suggestions were made to innovation communicator and marketers to construct Tweets combining two or more factors in the framework in order to increase the viral effects.

10. Policy Implications and Directions for Future Research:

The paper complements the traditional innovation cities list with the study of cities' innovation reputation from a social media respective. By studying conversations on one of the most influential social media – Twitter, and using Wordle as a main approach to analyze the massive quantities of data about innovation and cities, the paper identifies key factors in the messages on Twitter for building an innovative reputation about a city. Results of this study provide insights for marketers, communicators and city developers to improve the perception of cities' reputations for innovation, in a global view, to identify and support the influencers, and to acknowledge best communication practices through Twitter on the topic of innovation – to better build a city's reputation of "innovation" and to use social media to manage the brand of the city. For academic researchers, this study reveals new methods and metrics for tracking and measuring perceptions of innovation through social media. It gives new possibilities for finding patterns in easily accessible data and using those patterns to inform decisions.

The 20 cities in the study were selected with the reference to the Innovation Cities™ Program rank. And the synergy model in this paper is based on the study of the top three cities with most tweets about innovation. Hence, the study doesn't closely look into the tweets about other cities in the Innovation Tweet Dataset. One of the further research directions will be a completion of the rank list of innovation tweets about all the cities in the Innovation Twitter Dataset. Specific content analysis will be made for more cities to further identify key factors and patterns to improve the framework.

Social networks have emerged as a critical factor in information dissemination, search, marketing, expertise and influence discovery (Lerman & Ghosh, 2010). With the successful introduction of content tagging, geolocation interference maps, personal identification, device synchronization, and privacy protocols, the personal area network of the future will become a reality (Russell, 2009a). For example, Twitter turned on geo-location feature for Tweets tagged with location in November 2011 (Siegler, 2010) and soon after that, the location check-in was available on Twitter mobile apps as well. This provides researchers more information about where the message is being tweeted to study the conversations in different regions more precisely. The tracking, monitoring and visualization software required to retrieve, archive and process the data is evolving too. The use of graphic images to represent social configurations is important because "[i]t allows investigators to gain new insights into the patterning of social connections, and it helps investigators to communicate their results to others" (Freeman, 2009). TwitterExplorer (Pöschko, 2011) is such a tool that is able to visualize the network of Twitter hashtags about innovation and locations. TwitterExplorer is a tool for exploring hashtags on Twitter, created by Jan Pöschko. Each hashtag is connected by a weighted edge to its 10 most co-occurring hashtags. The node positions were calculated using the Fruchterman-Reingold algorithm implementation in NetworkX[3] with 50 iterations and are stored in a QuadTree[4] for fast access. The 500 most frequent hashtags in the graph were partitioned into 20 clusters using kmetis[5] and are displayed in different colors: http://twex.poeschko.com/innovation/. Future research will further explore the network of the social conversations about innovation and cities by using TwitterExplorer. In addition, the visualization network reveals the knowledge flow through Twitter across different nodes. It will help researchers, city developers, marketers, and communicators to further understand how to brand a city and build its reputation within a global innovation ecosystems network.

[3] NetworkX is a Python package for the creation, manipulation, and study of the structure, dynamics, and functions of complex networks. (http://networkx.lanl.gov/)

[4] A quadtree is a tree data structure in which each internal node has exactly four children. Quadtrees are most often used to partition a two dimensional space by recursively subdividing it into four quadrants or regions. The regions may be square or rectangular, or may have arbitrary shapes. This data structure was named a quadtree by Raphael Finkel and J.L. Bentley in 1974. A similar partitioning is also known as a Q-tree. (http://en.wikipedia.org/wiki/Quadtree)

[5] KMETIS is a C program which partitions the nodes of a graph using the METIS library. (http://people.sc.fsu.edu/~jburkardt/c_src/kmetis/kmetis.html)

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