Between a Rock and a Cell Phone:
Communication and Information Technology Use during the 2011 Uprisings in Tunisia and Egypt

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ABSTRACT

Many observers heralded the use of social media during recent political uprisings in the Middle East, even dubbing Iran's post-election protests a "Twitter Revolution". The authors seek to put into perspective the use of social media in Egypt during the mass political demonstrations in 2011. We draw on innovation diffusion theory to argue that these media could have had an impact beyond their low adoption rates due to other factors related to the essential role played by social networks in diffusion and the demographics of Internet and social media adoption in Egypt, Tunisia and (to a lesser extent) Iran. To illustrate the argument the authors draw on technology adoption, information use, discussion networks and demographics. They supplement the social media data analysis with survey data collected in June 2011 from an opportunity sample of Egyptian youth. The authors conclude that in addition to the contextual factors noted above, the individuals within Egypt who used Twitter during the uprising have the characteristics of opinion leaders, that is, a group of early adopters with influence throughout their social circles and beyond. These findings contribute to knowledge regarding the use and impact of social media during violent political demonstrations and their aftermath.

Keywords: *Innovation Diffusion, Middle East, Mobile Phones, Social Media, Social Networks*

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THE ROLE OF SOCIAL MEDIA IN POLITICAL CRISES

Protesters took to the streets with "a rock in one hand, a cell phone in the other," according to Rochdi Horchani – a relative of Mohamed Bouazizi, the 26-year-old Tunisian street vendor who set himself on fire in December 2010 to protest police harassment and corruption (Ryan, 2011). Bouazizi's death in early January 2011 as a result of his burns triggered riots leading to the downfall in mid-January of the 23-year reign of Tunisia's President Ben Ali. A wave of protests against Middle East authoritarian governments followed in Egypt, Libya, Bahrain, Algeria, and Syria, and came to be dubbed the 'Arab Spring'. Starting in July 2010, prior to the uprising, WikiLeaks began to release confidential State Department cables indicating that the US did not much admire the authoritarian leaders in many of these countries – a development played out via a set of online documents that certainly may have contributed to Arabs' confidence in protesting. In addition, much credit has been given to the role played by social media used by citizens to share with each other and with international media the news of what was happening in the streets.

On June 13, 2009, the day the Iranian government announced controversial results in Iran's June 12th Presidential elections, hundreds of thousands of protesters came to Azadi (Freedom) Square in Tehran. In the protests that continued despite a number of deaths and injuries, the Western media declared this a 'Twitter Revolution' (Grossman, 2009; Schleifer, 2009). The role of Twitter, YouTube and Facebook, among other social media, in mass political protests has been heralded in the Arab Spring, as well. In Tunisia, Facebook became the medium of choice among social media, because Twitter adoption was very low and the (now former) Ben Ali government blocked Flickr and YouTube (Lotan et al., 2011; Saletan, 2011). In Egypt Facebook was also more widely adopted than Twitter, but Twitter is more resilient to Internet blockage by government. That is, Twitter can still be used over cell phones, which have a very high adoption rate throughout Egypt, Tunisia and Iran as well as the rest of the Middle East (described below).

Massive protests of corruption and unemployment over 18 days between January 25 and February 11, 2011 (primarily in the two largest cities, Cairo and Alexandria) led to the end of the 30-year reign of President Hosni Mubarak. To constrain the flow of cell phone communications from areas of Tehran where post-election protests were taking place, e.g., Azadi and Ferdowsi Squares and along Vali Asr Street, the Iranian government appeared to have restricted bandwidth on cell phone towers (Sohrabi-Haghighat & Mansouri, 2010). The authors also heard (through hearsay not verified) that to communicate without depending on the cell towers during demonstrations, people would sometimes pass messages to nearby fellow demonstrators using Bluetooth technology between cell phones. The Egyptian government also restricted cell phone traffic in areas of Cairo (Tahrir Square) and Alexandria during demonstrations, and cut off Internet access completely (Singel, 2011) for several days in January 2011. This type of government restriction of traffic on cell towers also was reported in the mass street protests over disputed elections in Belarus (Zuckerman, 2009; Morozov, 2011).

In this paper we put the use of social media, especially the micro-blogging service Twitter, into the larger perspective of diverse information sources during the political uprising in Egypt that led to the resignation and departure of President Mubarak on February 11th, 2011. We compare social media use in Egypt with that of Tunisia (leading to the ouster of the 23-year reign of President Ben Ali) and of Iran (a non-Arab Middle Eastern country) during contested presidential elections in June 2009. We see similar technology adoption, demographic and social patterns in Egypt, Iran, and Tunisia where the Internet, cell phones, and most recently social media have been used to contribute to political uprisings (Kavanaugh, 1994; Kavanaugh, 1998; Kavanaugh, 1999; Kavanaugh, 2004).

We consider the use of social media during potentially violent political uprisings similar to their use during natural and man-made disasters (Kavanaugh, Yang et al., 2011). That is, people use social network systems, twitter and blogs to communicate situation awareness and other information during disaster conditions or conditions of social convergence, such as mass rallies and political demonstrations (Hughes et al., 2008; Hughes & Palen, 2009). This is part of a growing research area known as *crisis informatics,* so named by Hagar (Hagar, 2007) and extended by Palen, Hughes, and colleagues (Hughes et al., 2008; Palen et al., 2009; Starbird & Palen, 2011), among others. Crisis informatics pertains to the use of communication channels and messages to coordinate activity and convey information among citizens, rescue workers, government agencies, and others in situations of disaster and of social convergence. The recent literature on crisis informatics includes analyses of information seeking behavior following such disasters as 9/11 (Schneider & Foot, 2004), Hurricane Katrina (James & Rashed, 2006), the Virginia Tech shooting tragedy on April 16, 2007 (Vieweg et al., 2008; Palen et al., 2009; Sheetz et al., 2010), the Haiti earthquake, and the Japanese tsunami, among many others. We draw on methods and findings from these and other crisis informatics studies.

Conditions during some mass political uprisings, including those of the Middle East, are crises both for citizens and governments. For citizens, there is potential and actual violence, resulting in fear, injury, or death among participants at the hands of government forces or rival groups (e.g., several hundred deaths were reported from the initial crackdown by pro-Mubarak forces). For governments, there is the threat of instability and sometimes there is actual collapse (as in Egypt and Tunisia, but not Iran). In this paper, we focus on information sharing during the uprisings among the general public as opposed to rescue personnel or government officials.

Demographics in Egypt, Tunisia, and Iran

Egypt is the most populous Arab country with 84.5 million inhabitants in 2010; Tunisia has a much smaller population of 10.5 million in 2010, according to The World Bank (IBRD, 2010). Young people (aged 15-29) make up the largest proportion of the total population in most of the Middle East (Dhillon & Youssef, 2009). They are about a third of the total population in Egypt (29%) and Iran (35%) (Assaad & Barsoum, 2009; Salehi-Isfahani & Egel, 2009). Young people are often both relatively well educated, as mandatory primary education has led to significant education attainment in the past three decades, and unemployed, as it is difficult for the labor market to absorb the youth bulge (Assaad & Barsoum, 2009). The lack of good job opportunities for young people, together with their large numbers, has contributed to the rising sense of frustration and anti-government sentiment (Dhillon & Youssef, 2009). It has been well established that Egypt, Tunisia, and Iran are characterized, like many countries in the Middle East, as authoritarian, with varying levels of censorship over broadcast media, such as newspapers and TV (Richards & Waterbury, 2007; Moore & Springborg, 2010). While some elections are held at the parliamentary and presidential levels, candidates are carefully vetted and elections have been marked by allegations of fraud.

THE ROLE OF SOCIAL NETWORKS IN DIFFUSION OF INNOVATION

We use the theoretical framework of diffusion of innovation (Rogers, 1986; Rogers, 1995) to argue in this paper that while adoption of social media, such as social networking sites (SNS) and Twitter, are generally very low in the region, they could have had an impact beyond their

numbers due to a combination of related factors. These factors specifically are: concentration of Internet and especially social media adoption among young people, a disproportionately large number of young adults in the population, and the frequent sharing of information among social network members. While sharing information is fundamental to social networks (Wellman & Berkowitz, 1988; Stanley, 2005), social ties in Middle East societies tend to be strong and communication among members is frequent (Bayat, 2011). Innovation diffusion theory addresses the spread of innovations of various kinds, such as, new ideas, products, services or information throughout a social network.

The early adoption of ICT, like other innovations, is typically led by opinion leaders, i.e., the 10-15% of any society who are interested in new ideas, products and information, and are respected by members of their social networks who turn to them for advice (Rogers, 1986). Standard measures of opinion leadership include higher education levels (even among low socio-economic groups), greater exposure to media, greater talkativeness and sharing of information among social networks. Opinion leaders (also called influentials) play a central role in finding and evaluating information from mass media and other sources, and sharing it actively with people in their social circles (Keller & Berry, 2003). In this way, social networks are essential to innovation diffusion. The essential role played by opinion leaders in innovation diffusion is the basis of the two-step communication flow model (Katz & Lazarsfeld, 1955). Katz and Lazarsfeld specified a model in which communications from mass media (i.e., newspapers, TV, and Internet) are received and evaluated by influentials who then share their interpretation of that information to members of their social networks and sometimes the interested public. Various studies of Twitter have attempted to identify influence and influentials among twitterers on a given topic or domain area (Gomez-Rodriguez et al., 2010; Mustafaraj et al., 2011).

Information Communication Technology (ICT) Adoption in Egypt, Tunisia, and Iran

The adoption of information and communication technology (ICT) includes satellite television, private television networks, mobile phones, and the Internet, as well as social media (e.g., Facebook, Twitter). The diffusion of satellite communications (requiring the purchase of a satellite dish) and of privately owned broadcast (over-the-air) networks with Middle East news, talk shows, and political discussion has laid a foundation for rising expectations among citizens, businesses and other organizations (Alterman, 1998). The London-based Middle East Broadcast Corporation introduced Arab news and entertainment programming in 1991. Since 1996, Al-Jazeera TV, based in Qatar, covered Arab news and feature stories, and has expanded to global news and multiple languages (i.e., Arabic, Turkish, Persian, and English). Al-Jazeera has offered programming that is often critical of Middle East regimes and national or regional policies (Ghareeb, 2000). Although banned, satellite dishes in Iran are owned by many in the middle class, a segment of the population that has doubled in the past 15 years (Salehi-Isfahani & Egel, 2009). Internet adoption throughout the Middle East is quite variable; based on 2010 data from the International Telecommunications Union (ITU, 2010), World Internet Stats (http://www.internetworldstats.com/stats5.htm), and the OpenNet Initiative (http://opennet.net), Internet adoption in Tunisia and Iran were higher than Egypt at 36.8%, 35%, and 26.7%, respectively. Iran's Internet adoption has been growing on average 48% annually over the past 8 years, despite government constraints and censorship. It is helpful to compare these percentages with those for cell phone (2010), Facebook (FB), and Twitter adoption (2011), as shown in Table 1.

The most common SNS in many Middle Eastern states is Facebook (FB), but even FB usage is limited in the region. The highest

Table 1. Internet, Facebook, Twitter and mobile phone adoption

	Population (2010)	Internet (2010)	Facebook (FB) (2010)	Twitter (2011)	Cell Phone (2010)
Egypt	84.5 million	26.7%	5.5%	0.15%	87.1%
Tunisia	10.5 million	36.8%	17.6%	0.34%	95%
Iran	73.9 million	35%	0.22%	0.05%	91.3%

adoption levels in January 2011 were in the UAE (45%) and Israel (43%), with both Bahrain and Qatar at 34%, according to the FB Statistics portal Socialbakers (http://socialbakers.com) and the Dubai School of Government (Mourtada & Salem, 2011). At 17.5%, however, Tunisia is among the next highest (after Lebanon at 23% and Kuwait at 21%). In Egypt, only 5.5% of the population was using FB at the outset of the uprising, and in Iran less than 1% (an estimated 0.22%). The Iranian government has frequently blocked the site for long periods, although many Iranians have been able to use proxy websites to access FB. Changes in FB adoption since the uprising are shown in Table 2 (IBRD, 2010; ITU, 2010; Mourtada & Salem, 2011).

Not only do young people (15-29 years old) make up about a third of the population in many countries of the Middle East, including Egypt, Tunisia, and Iran, but young people are also the highest proportion of Internet users and of social media in particular (Mourtada & Salem, 2011; Mourtada & Salem, 2011). Youth make up about 70% of FB users in the Arab region generally, and make up 75% of FB users in Egypt and Tunisia (Mourtada and Salem 2011). Twitter adoption was very low across the Arab region in 2011, with less than 1% in Tunisia (0.34%), Egypt (0.15%), and Iran (0.05%). A 2009 study by the Web Ecology Project (WEP) analyzed over 2 million twitter posts (tweets) on the Iran elections between June 7 (just before the election) and June 26, 2009 (Beilin et al., 2009). The WEP analyses include tweets both inside and outside Iran, with the vast majority of tweets being posted from outside Iran. For users inside Iran, it was difficult to browse the web, because the Internet was extremely slow during the weeks leading up to and following the elections. The government restricted Internet services and blocked social websites, including Twitter and FB. Mobile phone adoption throughout the region is much higher across the total population than the Internet and FB. It is close to full adoption in Tunisia (95%), followed by Iran (71%) and Egypt (67%). Lowest are Yemen (35%) and the Palestinian territories (29%). Mobile phone adoption is key to communications in the streets not only for voice and short message systems (SMS), including Twitter, but also for capturing images and video on cell phones, despite blockages and bandwidth restrictions.

Table 2. Changes in Facebook (FB) adoption since the uprising

	FB Adoption (Jan 2011)	FB Adoption (April 2011)	FB Adoption (August 2011)	FB Adoption % Growth (Jan-Aug 2011)	FB New Users (Jan-Aug 2011) % Total Population
Egypt	5.5%	7.7%	10.5%	42%	2.3%
Tunisia	17.6%	22.5%	24.7%	29%	5.1%

METHODS

Our methods are comprised of the collection and analyses of Twitter data from Tunisia and Egypt, and survey data from an opportunity sample of young people in Egypt. We draw on our experiences, expertise, and observations in these countries and in Iran in our conclusions and discussion of results. We collected and analyzed SNS and Twitter data in Egypt and Tunisia, and supplemented these with survey data we collected from an opportunity sample of young adults (specifically, public and private university students) in Alexandria, Egypt. We also draw on our own observations as eyewitnesses of demonstrations in Iran in 2009 and Egypt in 2011. To evaluate Egyptian twitterers for opinion leadership characteristics, we used the same measures employed by some researchers, such as number of followers and biographical cues for 'elite' types of actors, such as mainstream media employees, political actors, activists, and researchers (Leavitt et al., 2009; Lotan et al., 2011).

Twitter Analyses

For the Twitter collections we used several tools, including Desktop Archivist, online (web) Archivist, and 140kit.com (Yang & Kavanaugh, 2011). We typed in keywords or phrases, and these tools collected tweets (i.e., short microblog messages or posts made by twitterers using the Twitter system) continuously for a given period of time. The tools also gave basic analyses for the data (i.e., how many people posted, their locations, language used, and some data visualizations). To identify opinion leaders, we used relevant data in our tweet collection, including the tweet ID (unique account name), tweet content, date posted, language, followers and user profile. User profiles give self-reported information about location and user bio (e.g., organization name, individual's hobby or interests) although users do not always tweet from the location in their profile or match their bio. We distinguished organizations from individual influentials, and used number of followers to measure centrality of twitterer, in combination with bio data to identify type of actor information (Lotan et al., 2011).

For Egypt, we collected tweets from January 28 through February 2011 that used one of a variety of hashtags, including: #jan 25, #Egypt, #Mubarak, #elbaradei, #Tahrir #Tunisia, or #Yemen. Most tweets included multiple hashtags related to the Middle East protests. For this paper, we focused our analysis on 514,782 tweets posted during the days just before, until just after, Mubarak's resignation, that is, the week of February 7 – 14, 2011. For Tunisia, we collected 65,784 tweets with multiple hashtags (#tunisia, #benali, #sidibouzid) from January 1 through February 1, 2011. We used visualizations produced by the Desktop Archivist and web-based Archivist.

To analyze the data further, we examined profile information, including twitterers 'bio' (profession or other self-identifying terms, some of which are not accurate or informative, such as "superman"), and location (e.g., country, city or region, sometimes not accurate or informative, such as "earth"). For location, we separated Tweets from profiles self-reporting a location inside Egypt and from tweets that self-reported locations outside Egypt or unusable locations (e.g., "nowhere"). For profiles including longitude/latitude data, we applied reverse-geocoding to find its region (e.g., city, country), and determine if tweets from the user were inside or outside Egypt. We were not able to analyze further the location based on content analysis (Starbird & Palen, 2012), so our results are only an approximation regarding location within Egypt.

In analyzing Twitter data to investigate the possibility that a disproportionate number of twitterers were opinion leaders, we focused on tweets that self-reported their location as within Egypt. To identify individual influentials within Egypt from influential organizations (e.g., news media tweets) we separated tweets by organizations from tweets by individuals. We manually examined the profile of the top 10% of all 3675 individual twitterers inside Egypt whose tweets

we collected between February 7 and 14, 2011. Although some studies use time data to measure the influence of twitterers (Gomez-Rodriguez et al., 2010), we followed other studies that used measures of 'centrality', including the number of followers, and 'elite types of status' derived from profile bios to evaluate opinion leadership and influence (Lotan et al., 2011).

In order to begin to put the use of social media in perspective with other sources of information used by Egyptians during the uprising we developed and administered a survey for an opportunity sample of Egyptian young people. Our sample was drawn from the student pool at Alexandria University. We cannot therefore generalize the results to the whole population, but rather we can only infer a pattern of information acquisition and dissemination based on the attitudes and behavior of a subset of Egyptian youth, and their friends and families. The Virginia Tech Institutional Review Board for Research Involving Human Subjects approved all procedures and instruments used in the study design, and the survey administration and analysis.

We adapted the survey from previous questionnaires of our own and other researchers who have been investigating the use of the Internet, and social media in particular, regardless of geographic location (Kraut et al., 2002). We added questions about diverse information sources that respondents might have used during the uprising, including various television and radio stations (e.g., Egyptian and Arabic channels), newspapers, and face-to-face communications with family, friends, acquaintances, and the public.

The survey consisted of questions related to ICT use by the respondent, ICT use by the respondent's family and friends, sources of information used by the respondent, communication with their family and friends, and reliability of information sources, followed by demographic items. ICT use asks how often respondents used different communication modes to obtain and provide information during the uprising. Communication modes include face-to-face conversation, cell phones, instant messaging, Twitter, Social Networking Sites, Email, Internet communication tools, and Photo sharing sites. Sources of information include family and friends, the Internet, Social Networking sites, Television, Radio, the Government, and Newspapers.

We translated the survey into Arabic and recruited participants from Alexandria University in Egypt. Specifically, we recruited 398 undergraduate students of one of the authors, Professor Elmongui. The students were from two programs: normal public programs (PP) and special scientific programs (SSP). The tuition and fees of the SSP students are orders of magnitude higher than the PP students. Professor Elmongui provided the students with a link to the online survey at the end of the semester. We hosted the survey online on a server managed by one of the authors.

RESULTS

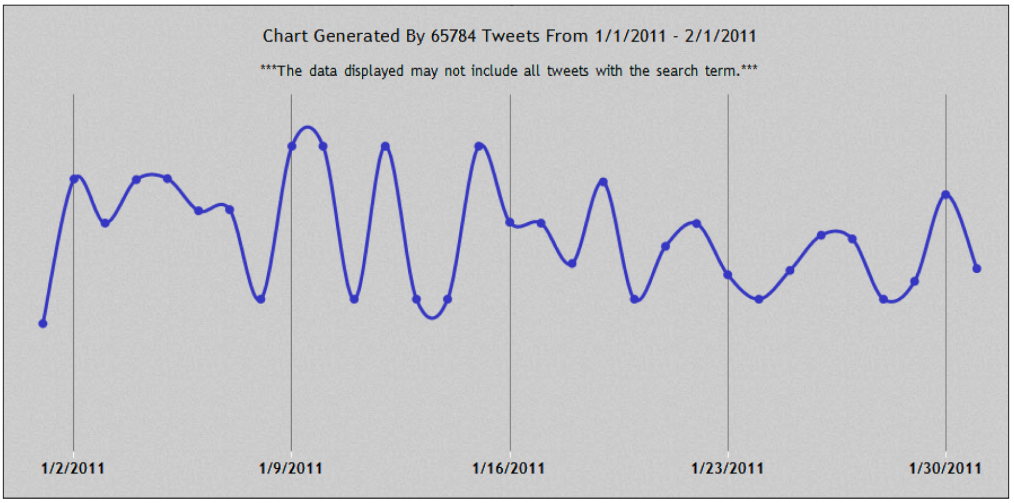
Our results lie in the collection and analysis of Twitter data (from Egypt and Tunisia) and the survey administered to university students in Alexandria, Egypt in June 2011.

Twitter Analyses: Tunisia

We collected and analyzed 65,748 tweets using multiple hashtags including #sidibouzid, #tunisia, and #tunileaks, from January 1 to February 1, 2011, that produced visualizations using Desktop Archivist and web-based Archivist. Almost two-thirds (63%) of the tweets during the month of January were retweets (i.e., original tweets that are copied by other twitterers and sent out under their Twitter account as 'retweets'). Many of these are related to news flashes, rather than individual comments on events.

Tweet volume over the month of January (frequency of tweets per day) displayed clear peaks in the volume of tweets on January 9th, 10th, 12th, and 15th that correspond to key events (see Figure 1). The peaks on the 9th, 10th, and 12th relate to the killing and wounding of protesters in clashes with police. During the night of the 14th Ben Ali flew to Saudi Arabia, on the 15th

Figure 1. Tweets by volume: Tunisia January 1 – February 1, 2011



Saudi Arabia officially announced they are hosting Ben Ali and his family. The peak of twitter activity on that day is generated by this event.

The sources of tweets are quite diverse, but predominantly come from the web, i.e., 52%. Additional sources include smart phones, as indicated by 'Twitter for iPhone' and 'Twitter for Blackberry'. Other sources include tweet search aggregator programs, such as Tweetdeck and Hootsuite. These programs allow users to monitor a set of specific Twitter accounts they are following (Figure 2).

The protests in Tunisia inspired similar street demonstrations across the Middle East, the largest of which have been in Egypt. During the unrest in Libya and Syria that continued throughout the summer and fall of 2011 there was a near blackout of communication media of all kinds in both countries.

Twitter Analyses: Egypt

The Egyptian government cut off access to the Internet and restricted the flow of cell phone network traffic on several occasions during the uprising. A ReTweet (RT) on the day of the million man march (February 1) for example says, "RT @[DK]: Mobiles around Tahrir Square are not working any more. Blocked too. Like internet #egypt #jan25 #cairo". Nonetheless, a stream of communications, including tweets, found their way out of the country.

We analyzed 514,782 tweets posted during the days just before until just after Mubarak's resignation, that is, the week of February 7-14, 2011 (Figure 3). The five most common hashtags and their frequency in our 514,782-tweet collection were #jan25, #egypt, #tahrir, #mubarak, and #cairo. This was a critical week of demonstrations and political developments, and correspondingly, Twitter activity showed clear spikes during key events and that a short time after the events these tags were no longer being used. Thus, the spike in tweets emerged, peaked, and receded within this critical week, recording the events occurring on each day in real time.

We used word cloud visualizations of the Tweets for each day to provide a high-level perspective of the information being communicated. Substantive differences in the word clouds exist for the peak days of February 8th, 10th, and 11th. Twitter posts on February 8 – a day after the release of activist and computer engineer Wael Ghonim during which he roused protesters -- shows the most common terms that appeared in the tweets (Figure 4). In Figure 4, Ghonim is dominant; however several other ideas represented also are interesting. First, a

Figure 2. Source of tweets: Tunisia January 1-February 1, 2011

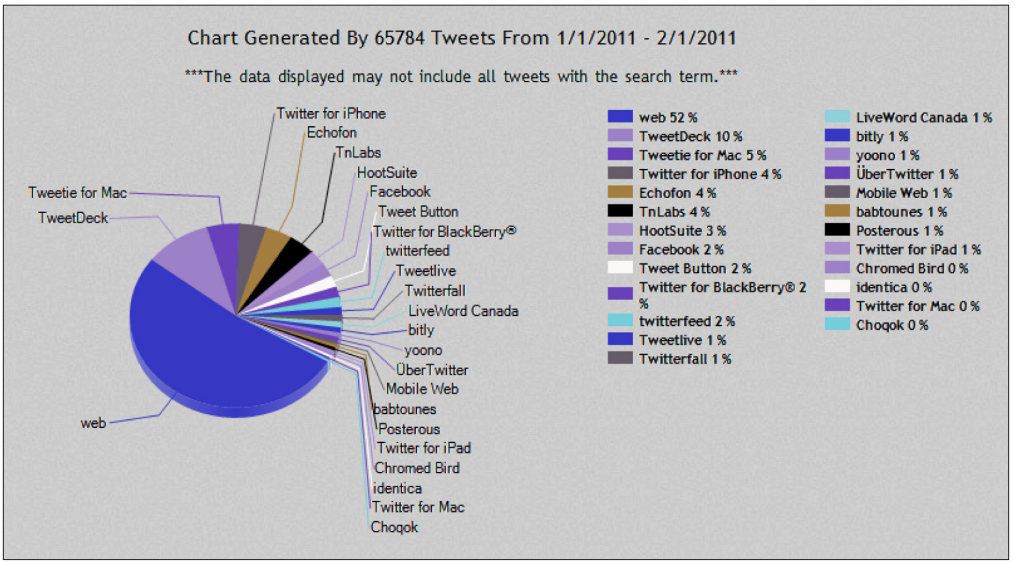
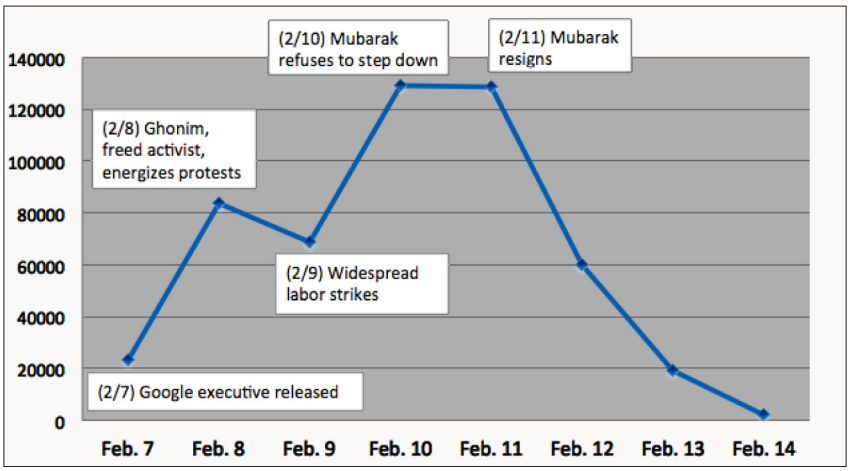


Figure 3. Tweet volume over time: Egypt (Feb 7-14, 2011)



theme of group involvement against the government is present in the "people, protesters, revolution, and freeegypt" words; secondly the names of potential replacements for Mubarak are identified in the words Suleiman, Omar, @3arabawy, and @monaeltahawy; and finally location identification with "cario, egypte, and Egyptian. No time references appear in these tweets, perhaps suggesting that protesters were assuming changes would occur quickly.

On February 10th Mabarak spoke indicating he would not resign. The word cloud for February 10 is shown in Figure 5. The changes in the predominance of terms appearing in tweets indicate the changing focus of communication related to Mubarak's radio address on February 10th in which he refused to resign. Gone are all

Figure 4. Word cloud of top tweets February 8, 2011

* hashtags appear repeatedly in the tweets, so we removed these terms from the word clouds.

of the references to Ghonim from February 8. The anti-government theme is still present, albeit with some different words, including: people, protesters, revolution, dictator, and uninstalling. The name of a potential replacement for Mubarak is still in the cloud. A new, and darker, theme emerges with the words violence and army. Time also is identified as an issue in words like: now, tomorrow, and go; perhaps because one of Mubarak's themes was to ask the people to wait for reforms to occur.

On the next day, February 11, 2011, Vice President Suleiman indicated that Mubarak had resigned. The @Ghonim tag reappears, perhaps indicating that his efforts are recognized as contributing to the success of the uprising. The anti-government theme still exists in the dictator, revolution, and uninstalling words. The time dimension is also represented in the now, Feb11, and ASAP words. No references to potential replacements are seen in this cloud. The location theme continues to exist in the Cairo and Egyptians words. A new theme related to countries outside Egypt emerges in the "world and Obama" words.

Overall the series of word clouds by day provide concise insight into the gist of the information flowing through the twittersphere. Showing the release Ghonim, the desire to move quickly, the potential for violence after Mubarak's speech, the appreciation of Ghonim for his efforts, and ending with the goal of opening Egypt to the world, after Mubarak's resignation.

To get a sense of where twitterers were tweeting from, we collected location data from twitterer profiles. The highest number of tweets (73,272) from any location, were from twitterers that identified their location as Egypt, this measure does not categorize locations given in Arabic script. The next most frequent tweets were from twitterers whose location was unspecified or unknowable, e.g., "here" (57068). The next highest number of tweets by location were from North America (37,268), the Middle East and North Africa (31,507), followed by the United Kingdom (UK) and Europe (22,650). The locations that are given in twitterer profiles can be different from the location where the actual tweets were posted, since twitterers travel. What is important to note is that the highest frequency of tweets appears to be within Egypt, whereas in the case of Iran during the June 2009 post-election demonstrations, studies estimated that there were fewer than 100 twitterers inside Iran with the vast majority outside (Beilin et al., 2009; Gaffney, 2010). twitterers outside Iran were tweeting

Figure 5. Word cloud of top tweets February 10, 2011

Figure 6. Vice President Suleiman announces Mubarak has resigned (Feb 11)

about events there, and often re-tweeting posts from users inside the country.

To evaluate opinion leadership among our collection of Egyptian twitterers, we first separated tweets by location (inside Egypt versus outside Egypt – including unknown locations) based on profile data. We had over 500,000 tweets in the one-week collection, with approximately 79,000 unique users and 4701 twitterers inside Egypt. Of the 4701 in Egypt, we further distinguished organizations from individuals to focus on individuals as influentials. We identified 26 organizations (e.g., Egyptian newspapers, TV channels, mobile service providers, travel agents) and 3675 individuals tweeting from Egypt. As noted,

based on measures employed by other studies, we evaluated influentials by several measures, most notably, number of followers and profile information in bios.

The top 10% of all 3675 individual twitterers within Egypt (i.e., 367 users with highest number of followers) had between 500 and 27,000 followers; the information users provide in their bios is generally consistent with the type of actor ("elite") in other studies of opinion leadership on Twitter. For example, at the very top, nine individuals had between 10,000 and 27,000 followers; another ten individuals have between 5000 and 9000 followers. Their bios indicate a variety of professions including correspondent for Al-Jazeera news, blogger/activist, award-winning journalist, co-founder/marketing executive, actor/filmmaker, social activist, writer/reporter, lawyer/executive director, veterinarian, and social media consultant. These are high status or high activism individuals with a large number of followers. Both the elite nature of their roles in society and their number of followers suggests these twittterers are opinion leaders. There are many twitterers with similar bio profiles scattered throughout the rest of the top 10% (367) of Egyptian twitterers, all of whom have 500 or more followers. There also is a long tail of 3308 twitterers who each have fewer than 500 followers.

Survey of Egyptian Youth

We report here the descriptive statistics of our survey of public and private university students. Our host server registered a total of 255 collected surveys; we had to eliminate 14 surveys that were blank, giving a total of 241 usable surveys (a 60% response rate). In all the results, the percentages we report are valid frequencies:

- **Demographics of Respondents:** There were slightly more female respondents (53%) than male respondents (47%); almost all (97%) were single. They all lived in the city of Alexandria or nearby towns. There was some confusion about the question we asked regarding the year respondents were born, so the data is not usable for many subjects. However, as these were upper level undergraduate university students, and 60% of usable responses were between (birth year) 1988 and 1993, we have confidence that the bulk of respondents were in the range of 19-24 years old;
- **Sources of Information and Communication during the Uprising:** Among their sources of information and communication used during the uprising, respondents' family members and friends figure prominently. Two-thirds of respondents (66.1%) reported daily face-to-face communication with their family and friends; an even higher proportion (80.2%) reported using their home phone or cell phone for daily voice or text communication with family members and friends. Only about a third (34.7%) reported face-to-face communication with people in the streets, shopkeepers, taxi drivers, or newspaper sellers as a source of information during the uprising.

Among broadcast media, the most popular TV channel was ON TV (87.5%), followed by Dream (83.5%), and Egyptian channels 1 and 2 (59.7%), plus foreign channels (46.0%), such as, French TV, CNN, and Voice of America. Also popular were other Arabic channels, including Al Arabiya (39.5%), Al Jazeera (31.9%), and Hora (29.4%). A large proportion of respondents (41.9%) wrote in names of other television channels, including ABC News, Al Yawm, Al Hayah, Al Alm News (Iranian), Al Mostagela, TV 5 Russia Today, and CNN. Most respondents (84.5%) reported they did not listen to the radio; this might be because they were watching and listening to television channels instead. Of the few who did report they listened to the radio, they used FM channels (6.9%), Middle East channels (4.9%), Cairo channel (3.7%), and other (2.9%). About two-thirds of respondents (69.8%) reported reading newspapers (offline). Online newspapers were among the most popular type of Internet sites visited by these participants (see next section) during the uprising.

All respondents reported having cell phones. The major use, as expected, was to make or receive phone calls (92.6%), but many respondents (65.2%) also reported using them to send or receive text messages, browse the Internet (49.2%), and take pictures (38.5%) and videos (33.2%).

- **Internet Use during the Uprising:** The vast majority of respondents (94.5%) reported they used the Internet during the uprising (January-March 2011). Of those using the Internet, most respondents (96.8%) were using the Internet everyday (89.1% were using the Internet several times a day). Respondents accessed the Internet from multiple locations, but the most common location was home (98.4%), followed by public places (36.7%), such as Internet cafes, and another person's house (29.4%). Only about a fifth (22.2%) accessed the Internet from work, and even fewer (14.5%) from school. On a typical day during the uprising, on average, respondents reported spending just over 7 hours per day on the Internet; the median number of hours a day was 6. Most respondents (76.9%) used English when they were using the Internet (including social network sites or Twitter). Although users can write their tweets in any language, the Twitter website (i.e., screen) did not have an Arabic language interface during the period of the uprising, although one was planned for release later in 2011. After English, more respondents (65.6%) reported writing in 'Franco-Arabic' (Arabic words using Latin script) than writing in Arabic (57.1%) or other languages (2.4%). (We did not include 'Franco-Arabic' tweets in our analysis of profile data of twitterers.) Newspaper websites were among the most popular websites visited (79.5%), followed by FB pages on the uprising (e.g., "We are all Khaled Said") (78.3%), FB News organization pages e.g., RNN (68.4%), News websites (e.g., Masarawy) (44.7%), and television news channel websites (28.7%);
- **Social Media Use during the Uprising:** The vast majority of respondents (97.9%) reported that they used a social network site (e.g., FB) during the uprising, and most of them (90.9%) used it every day (79.3% used it several times a day). The most frequently reported activity on an SNS was reading other people's posts (76.3%), followed by posting comments (71%), looking at site information of others (53.1%), posting pictures or videos (49.4%), joining groups (42.3%), and updating their own status (36.5%). Almost a third of respondents (31.8%) reported using Twitter (i.e., micro-blogging) during the uprising, with about a quarter (26.3%) using it at least once a week. Half of respondents (50.4%) were reading blogs; only a small proportion (5%) was writing blogs. Almost half of respondents (45%) were reading or writing blogs at least once a week. Most respondents (73.3%) were using some kind of Internet communication services such as Skype, MSN, or Yahoo messenger every day. The vast majority of respondents (95.1%) accessed video or photo sharing websites such as YouTube, Flickr, or FB, with 78.5% of the respondents using those sites every day;
- **Reliability of Information Sources:** The reliability of information sources was assessed by respondents on a scale of 0=not at all reliable, 1=low (the information was usually not reliable), 2=medium (the information was reliable some of the time), 3=high (the information was reliable most of the time). The overall mean for all information sources is 1.07, suggesting that regardless of information source, reliability of information was only slightly better than low. Face-to-face communication with family and friends, and SNS, scored highest on reliability at 1.59, suggesting that these sources are comparable. When family members and friends also are "friends" through SNS, this consistency makes sense as it measures the perceptions of the reliability of the same people. On

the reliability scale of 0 to 3 these are the only information sources that score barely beyond the midpoint of the scale, indicating that information is perceived as between usually not reliable and reliable some of the time. Television at 1.28 and internet sites, not including SNS, at 1.24 were rated the next most reliable, followed by the newspapers at .97, other sources at .80, and radio at .76. These values indicate that respondents believed that reliable information was usually not available. Finally, government sources were perceived as the least reliable at .28.

Women perceived F2F, 1.69 versus 1.47 ($p = 0.024$), SNS 1.70 versus 1.47 ($p = 0.022$), and newspapers 1.05 versus 0.86 ($p = 0.079$), as more reliable than men. However, women and men did not differ significantly on the reliability of information from Television 1.28 versus 1.27 ($p = 0.863$), Radio 0.70 versus 0.74 ($p = 0.118$), and government .30 versus .23 ($p = 0.343$). Overall, women see information sources as more reliable than men, 1.13 versus 0.99 ($p = 0.015$), albeit still providing low information reliability.

- **Change in ICT Use since the Uprising:** While over a third of survey respondents (39.6%) reported 'no change' since the uprising in their use of information received from face-to-face and phone communications with family, friends, and people in the streets, a similar proportion (37.9%) reported increases in these communications. Increases and decreases in television use as a source of information seem to cancel each other out, with 36.2% reporting increased use and 36.6% reporting decreased use since the uprising. A large majority reported no change in their use of radio, although this was underutilized previously, so respondents presumably continue to underutilize radio since the uprising. About half of respondents (49.8%) indicated that they had decreased their use of government sources of information since the uprising, while another 34% indicated no change. The biggest change among respondents' use of information since the uprising is in the use of social networking sites (FB or Twitter specifically noted) with 61.3% reporting increased use. This increase is consistent with findings from other recent studies (e.g., according to the FB statistics portal 'Socialbakers' the adoption of FB in Egypt has grown about 60% since the beginning of the uprising in January 2011). The number of FB users rose from about 5.5 million in January to an estimated 8.4 million in August 2011. That is, about 10% of the total population was using FB by August 2011; this is almost half (49%) of the total online population in Egypt;
- **Differences between Twitter and non-Twitter Users:** Several differences exist between respondents that used Twitter versus those that use social networking, but not Twitter. Twitter users reported they used the Internet for more years than others (8.8 years versus 7.1, $p=.039$), and used the Internet from more locations (2.36 locations vs 1.93, $p=.021$). Twitter users also were significantly more likely to view videos on the Internet (6.39 versus 5.93, $p=.035$), write blogs (3.23 versus 2.43, $p=.04$), and use more features of social networking sites (3.86 versus 3.38, $p=.088$), than respondents that used social networking sites but not Twitter.

Interestingly, Twitter users also are somewhat different from others offline, watching a larger variety of TV stations than others (5.09 rather than 4.22, $p=0.001$) and using more of the features on their cell phones than others (3.73 versus 2.93, $p=0.002$). Finally, Twitter users are more likely to receive information in face-to-face communications (2.08 versus 1.74, $p=0.002$) and to share more information with family and friends in face-to-face situations (6.14 versus 5.64, $p=.030$). Overall, these results suggest that Twitter users were more

involved with both technology and people during the uprisings than users that did not use Twitter. Twitter users and others also differ in their opinions of the reliability of information from government sources (.19 versus .31, p = 0.04). However, no significant differences in reliability of information exist for any of the other information sources for Twitterers versus respondents that do not use Twitter. Indicating that Twitter users also perceive information reliability as low, similar to the results presented above for all respondents.

Respondents' Friends and Family: The majority of respondents reported that their friends and family members had access to the Internet (87.6%) and cell phones (92.6%). They were using social network sites (82.9%), such as FB, and were looking at video or photo sharing websites (84.1%). About a third (35.7%) of respondents' reported their families and friends were reading or writing blogs. The great majority of respondents (90.1%) communicated face-to-face at least once a week with family and friends; over two-thirds (69.3%) communicated face-to-face every day. A large majority of the respondents communicated daily with friends and family using SNS (83.3%), their cell phone (70.5%), and instant messaging services, such as MSN or Yahoo messenger (63.5%); over a third communicated daily with friends and family by email (36.9%) or home phone (37.8%). The vast majority of respondents (93.5%) reported that they shared information they obtained from the Internet with their friends and family. A similar majority (94.3%) reported that their family members and friends shared with them information they obtained from the Internet (including FB, YouTube, and Twitter).

CONCLUSION

Many observers of the uprisings in Iran in 2009 and the Arab states in 2011 heralded the use of social media, such as social network sites, photo and video sharing sites and blogging or micro-blogging services. Some went so far as to declare the Iranian protests a 'Twitter Revolution' (Grossman, 2009; Schleifer, 2009). The role of Twitter and other social media in mass political protests has been the focus of much attention in the Arab Spring, too. However, the adoption rates of social media in Iran, Tunisia and Egypt were very low. Could these media really have the important role in the uprisings that so many observers, officials and news media suggested? We employed a diffusion of innovation approach, including the role of social networks and opinion leaders, to analyze the adoption and use of social media during the Egyptian uprising in 2011. We have argued that despite their low adoption rates, social media could have had a disproportionate impact due to a combination of demographic, social network, and information and communication technology (ICT) adoption factors. We compared Egypt with the cases of Tunisia and Iran where the use of social media also had a seemingly disproportionate impact. There is a high percentage of young people (aged 15-29) among the total population in most Middle Eastern countries, and a high proportion of Internet and social media users among young people. These two factors allow this segment of the population to draw on many online sources of information besides the more widely used mainstream media of television and newspapers. Additionally, in Middle Eastern societies close friends, and family and extended family members tend to communicate with each other on a fairly regular basis whether face-to-face, by telephone, or online. Given these conditions, we expect young people routinely shared information they obtained from online sources with other family and friends. As diffusion theory has established, social networks are essential to the communication of new information and ideas. The two-step flow of communication model emphasizes the role of young people as opinion leaders in sharing information they obtain from mass media with members of their social networks.

Our survey respondents' use of the Internet and some social media (social network sites, especially FB and photo sharing sites) was quite high. This is not unexpected since our

opportunity sample is taken from a population of university students. Use of Twitter was much less (just under one third). They all had cell phones and used them not only to send and receive phone calls, but also to send or receive texts, browse the Internet and to look at photos or videos. What we have tried to illustrate is that these young people shared information that they had obtained from various sources, including social media, with their friends and families. Moreover, the vast majority of respondents reported that their friends and families shared information that they had obtained from the Internet (including FB, YouTube, or Twitter) with them.

The low reliability of information from all sources is likely a characteristic of chaotic situations, like the uprisings. That SNS and other internet sites, i.e., relatively new information sources, are perceived as reliable as traditional communication modes including face-to-face, television, radio, and newspapers, shows how deeply (and perhaps rapidly) these technologies are embedded in the lives of respondents. It is not surprising that government sources were least reliable and well below all other sources. Perhaps the overall low reliability of information encourages a broader search and confirmation processes for information, leading to the use of many sources and the high levels of information sharing found in this study.

The differences we found between survey respondents who used Twitter during the uprising and those that used social networking, but not Twitter, suggest consistent communication behavior of opinion leaders. Twitter users are significantly more experienced as Internet users and are more likely to view videos on the Internet, write blogs, and to use more features on SNS and on their cell phones than respondents that use social networking sites but not Twitter. Twitter users' offline communication behavior is also significantly different from others, specifically, seeking more information sources from broadcast television and receiving and sharing information in face-to-face communications with family and friends. Twitter users were significantly more involved with both technology and people during the uprisings than users that did not use Twitter, consistent with the communication behavior of influentials.

Our analysis of Twitter posts from Egypt and user profile data also support the idea that individuals actively tweeting from Egypt showed characteristics of opinion leaders. Specifically, the top 10% of all 3675 individual twitterers within Egypt (i.e., 365 users with highest number of followers) have between 500 and 27,000 followers; the information users provided in their profile bio was generally consistent with the type of actor ("elite") in other studies of opinion leadership on Twitter. While our sample is limited, it is possible to see at least trends from our survey data among a segment of the population in Egypt that is important for both its large proportion to the total population and its large proportion of Internet and social media users. Ultimately, it seems sufficient for a few young people within a household or extended family network to have access to online information and discussion for the broader population to become aware of information and ideas beyond the more traditional sources of information, such as, television, radio, and newspapers. What the social media add to the other Internet sources of information, such as online news sites, are the opportunities for users to discuss and compare information with trusted social network sources, such as FB friends and friends of friends, as well as Twitter users whom they choose to follow. In this way, from the few to the many, social media can have a larger role in informing society than its adoption levels across the entire population would suggest.

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