Analyzing the Use of Twitter to Disseminate Visual Impairments Awareness Information

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Abstract—People with visual impairments have been surrounded with myths and misconceptions that have made it challenging for them to live as productive members of the society and have partly contributed in making the majority live in substandard living conditions. To shift the public’s focus from being on the disability to be on the abilities of the visually impaired, non-profit organizations and government agencies have conducted a series of campaigns to spread awareness about visual impairments. Social media platforms, such as Twitter, has become the primary channel to diffuse information to the public. The goal of this paper is to analyze the use of Twitter as a social media platform to spread information during visual impairments awareness campaigns. We focused our analysis on five key concerns: (i) the characteristics of active users during the event, (ii) the major players in information dissemination, (iii) the tweets’ common topics (iv) the reachability of information, and (v) the temporal tweeting behavior. We report the results of the campaigns along with the design of an effective communication strategy of a campaign.

Keywords—Disability awareness, Social media campaign, Visual impairment

I. INTRODUCTION

According to the World Health Organization (WHO), around 285 million of the world’s population are visually impaired, 39 million of whom are blind. Of all visual impairments, around 80% can be cured [1]. While the number of people with visual impairments seems to be large, it only constitutes around 4% of the world population of approximately 7.4 billion [2]. This could have contributed to surrounding people with visual impairments with myths that underestimate their abilities. Some of those myths include the inability of blind people to handle most jobs; the cost of accommodating blind people in a workplace is too high; blind people need relatively more supervision; and blind people cannot read printed or handwritten materials [3]. While the significance of such myths is unknown, they convey the public perception about the productivity of the visually impaired, which could in part be contributing to having 90% of the world’s visually impaired at low-income [1]. The lack of proper awareness for both the visually impaired (i.e., their impairment could be curable or preventable) and the public (i.e., visually impaired individuals can function as productive members of the society) has brought the attention of government agencies and nonprofit organizations to spread awareness about a variety of visual impairment misconceptions and issues. To achieve this, several worldwide awareness campaigns have been conducted. Examples of such campaigns include the Blindness Awareness Month [4], the White Cane Week [5], the World Sight Day [6], the White Cane Safety Day [7], and the Meet the Blind Month [8].

With social media platforms, billions of users can be conveniently reached with the least cost possible. Using Twitter, for example, campaigners can utilize its free and powerful message broadcasting features to reach millions of users. Research has shown the significant role of social media in disseminating information about public health awareness [9], [10], [11], [12], situational awareness [13], [14], and spreading rumors [15].

With this wealth of publications that analyzed the use of social media to diffuse information of a certain type, we found no studies that target disabilities information dissemination using social media. This paper aims to study the use of Twitter as a social media platform to disseminate information during visual impairments awareness campaigns. Our study is based on data collected from Twitter during the observance of four visual impairments awareness campaigns that took place in October, 2016. Based on the collected data, our study attempts to answer the following questions:

(Q1) What are the characteristics of those who were active during the event?
(Q2) Who are the major players in information dissemination?
(Q3) What kind of topics the tweets were about?
(Q4) What is the reachability of the disseminated information?
(Q5) What’s the temporal tweeting behavior during each selected campaign?

To answer these questions, a sample of the posted tweets during the month of October 2016 were extracted. English-only tweets that match the hashtags and keywords relevant to four selected visual impairments awareness campaigns, namely: the White Cane Safety Day, the World Sight Day, Meet the Blind Month, and the Blindness Awareness Month, were used. Tweets metadata was also collected in addition to the users’ available profile information. The month of October was used as the candidate search duration because it is the only declared month of the year for visual impairments awareness.

We believe that the outcomes of our study are beneficial in a number of ways. Sociologists can use similar analysis to update their understanding of the public’s perception about the visually impaired and of the inclusive issues associated with this type of disability. The outcomes give visual impairments awareness campaign managers insights about the role of each class of users in spreading information about visual impairments, which would help them develop better communication strategies for future campaigns.
by campaign managers to gauge the effectiveness of their communication process by comparing the discussed topics with their campaign goals. Human-computer interaction researchers and practitioners can also use the outcomes to broaden the context of their developed solutions and add to the problem space of the field of accessibility computing.

In the rest of the paper, Section II presents related studies; Section III discusses the methodology and presents the results; Section IV discusses the findings; and Section V concludes the paper.

II. RELATED WORK

The significant role that social media has played in information dissemination attracted researchers from several fields to analyze how they have been utilized to diffuse information. We did not find a study, however, that is concerned with the dissemination of awareness information of disabilities in general or visual impairments in particular. Therefore, we survey research efforts that are closest to disabilities. In particular, we summarize studies that analyze the use of social networking sites, especially Twitter, to disseminate health awareness information.

Thackeray et al. [16] studied how Twitter is used during the Breast Cancer Awareness Month. The study attempts to answer four key questions: (i) what’s the temporal tweeting behavior throughout the month, (ii) which user group among the three (individuals, celebrities and organizations) tweets the most, (iii) how far does the tweets reach, and (iv) what kind of information was diffused during the event.

Bravo et al. [17] studied the underlying themes of the tweets posted during the 2013 Movember Canada. The authors performed qualitative content analysis of all tweets having the hashtag Movember during the month of November 2013 and are generated by Canadian users.

Sisco et al. [18] analyzed how social media sites are used by breast cancer nonprofit organizations from activity, credibility and transparency perspectives. Specifically, the study discusses four concerns: (i) breast cancer non-profit organizations activity on social media websites, (ii) the relationship between the organizations activity and credibility, (iii) the relationship between the organizations activity and transparency, and (iv) the relationship between the organizations credibility and transparency.

Harris et al. [19] studied how Twitter is used by Local Health Departments to diffuse diabetes awareness related information to their constituents. Specifically, the investigation of this study is concerned with four key inquires: (i) the number of local health departments tweeting about diabetes, (ii) the existence of a positive correlation between having a diabetes-related programming and the likelihood to tweet about diabetes, (iii) the existence of a positive correlation between diabetes rate in a jurisdiction the likelihood to tweet about diabetes, and (iv) topics to which the posted tweets are related.

Lapointe et al. [12] studied how organizations and individuals use social media to promote cancer awareness. Specifically, the authors aim to develop a social media based collaboration model that describes how individuals and organizations interact to raise awareness about cancer. The authors conducted a case study based on six different nonprofit cancer awareness organizations. Data was collected from three different sources: (i) the organizations’ used social media tools, (ii) interviews with the organizations’ CEOs, and (iii) documentations that demonstrated mission-related information about each organization.

Chung [11] conducted a study to understand the use of Twitter as an information dissemination tool for health campaigns. The author framed the study within three questions: (i) which users tweet about those campaigns, (ii) to what extent are Twitter features used among active users, and (iii) who are the big information dissemination players. The study used the CDC’s Tips From Smokers Twitter campaign that took place in 2015 as a case study.

Dyar et al. [20] studied which events and individuals trigger discussions on Twitter about the topic of antibiotics. The study is based on a one-year worth of tweets that contained the term antibiotics.

Scanfeld et al. [21] conducted a study to identify the key categories of Twitter’s content related to the topic of antibiotics. The authors paid a special attention to the cases associated with the misunderstanding and/or abuse of antibiotics.

Reavly et al. [22] studied the usefulness of Twitter as a tool measure the stigmatizing attitudes towards depression and schizophrenia. The study is based on a bi-daily collection of tweets containing the hashtags depression or schizophrenia over a period of seven days. The tweets were classified based on their category and their user type. Tweets that belonged a stigmatizing behavior related or personal experiences categories were given a special attention by selecting them to further classification.

Neiger et al. [23] attempted to propose a set of Key Performance Indicators (KPIs) along with associated metrics to measure the effectiveness of social networking sites usage for health promotion purposes. Based on the identified social media usage purposes by the CDC (e.g., market insights, brand promotion, critical information dissemination, reach expansion, and public engagement), the authors associate a set of KPIs and metrics to measure the effectiveness of using social media for such purposes.

III. DATA ANALYSIS

We collected the data between October 12-18, 2016 to cover the awareness campaigns [24]. This period includes the White Cane Day (October 12th – also recognized as Blind Americans Equality Day on October 15th), the World Sight Day (October 13th), and one-week sample of both the Meet the Blind Month and the Blindness Awareness Month that both take place during October. In addition to duration, the following keywords and hashtags were used as part of the search criteria: #WhiteCaneDay, #WhitecaneSafetyDay, #BlindAmericansEqualityDay, white cane day, white cane safety day, national white cane day, #NationalWhiteCaneDay, blind americans equality day, #MeetTheBlindMonth, #mtbm16, #BlindnessAwarenessMonth, meet the blind month, blindness awareness month, world sight day, #WorldsightDay, #WSD2016, and #withoutSight.

While it was tempting include general search keywords that could be relevant to our topic such as blindness or visual impairment to get more results, we decided not to due to two reasons. First, keywords such as blindness are frequently used to signify the blindness of the mind, making...
the term popular in religious and political contexts, which could add a lot of noise to the analysis. Second, the main focus of this work is to analyze the tweeting activity during the events of interest. Adding tweets that were not intended to participate in the awareness of such events could distort our analysis.

The adopted search criteria resulted in a total of \( N = 6,143 \) tweets. The collected tweets were processed to extract five data items from each tweet: the tweet text, the tweet type, the tweet posting time, the tweeting user, and the retweeted user. A tweet was classified to three types: original, reply, retweet. From each tweeting user, we were interested in the user’s screen name, username, bio text, and number of followers. Such information was useful to classify users to different groups (Q1), identify major players (Q2), conduct per-group topic analysis (Q3) and compute information reachability (Q4). Finally, the tweet posting time was useful to analyze the tweeting temporal behavior (Q5).

Our questions were also the focus of similar studies by Thackeray et al. [16] and Chung [11], but these studies focused on analyzing breast cancer and smoking succession awareness campaigns, respectively. In the following sections, we describe how the processed data was used to answer each of the five questions.

A. Users Classification (Q1)

We classified users using the decision tree approach of [16]. We classified users to three categories: organizations, Twitter celebrities, and individuals.

Organizations are users whose screen name, username, or bio text matched one or more of a set of filter terms. The filter terms used are the following: organization, association, federation, foundation, NFB, institute, school, university, college, project, firm, incorporation, accessibility, disability, braille, charity, radio, services, news, blindness, resources, company, academy, health, department, forum, campaign, network, city, county, state, agency, government, group, marketing, society, press, official, division, us, we, president, CEO and committee. Similar to [16], Twitter celebrities are twitter users who are not organizations and have more than 100,000 followers. We deviate from the classification approach of [16] that also considers verified accounts as celebrities. Twitter’s verified accounts approval process does not mandate a large followers base [25] and we are interested in studying the effect of information dissemination by potential information hubs. We therefore only consider an account as a celebrity if it belongs to an individual who has a very large followers base. The rest of the users were classified as individuals.

Studying the tweeting behavior of organizations helps in understanding how such entities (e.g., for-profit, non-profit and government organizations) utilize Twitter during such campaigns. Twitter celebrities were distinguished from organizations and individuals because of their special role in information dissemination as they have both large and diverse audience. Their messages, therefore, would have a greater chance of reaching more communities across Twitter network. Studying individuals tweeting behavior, on the other hand, helps in gaining insight about the reaction of the public to the broadcasted messages in addition to their perception of the objectives of the campaign.

After users were classified, we conducted two post-classification quality iterations. First, we conducted a quick quality inspection of the classification and obvious false positives were manually corrected. Second, we compared the screen names of organizations accounts against a database of \( \approx 140,000 \) common first and last names [26] and automatically classified the matches as individuals accounts. We performed the second step after observing a large portion of individuals accounts that were mis-classified as organizations.

There was a total of 4,896 unique users with individuals representing the largest active users group followed by organizations and then celebrities. Summary of the results is shown in Table I. Organizations generated more than half of the original tweets followed by individuals while celebrities generated few. Organizations and celebrities, however, had almost the same average number of tweets per user with an average of 0.8 and 0.7 original tweets per user, respectively.

Content propagation, represented by retweets, was the highest among individuals which supersedes that of organizations and celebrities. The same pattern applies to the average retweets per user where individuals had an average of 0.9 retweets followed by 0.7 retweets per an organization account and 0.5 retweets per celebrity user.

Finally, organizations and individuals had comparable number of replies. Organizations, however, had a higher number of replies per user compared to individuals. Celebrities had no contribution in terms of replies.

Organizations were the most active in terms of their total generated original tweets, followed by individuals and celebrities. When it comes to the mean original tweets per user, however, celebrities’ mean original tweets were comparable to that of organizations. Retweets constituted the majority of the generated content, forming approximately 68% of the overall tweets. The majority of the retweeters were individuals, who contributed in generating approximately 80% of the retweets. Replies, on the other hand, were by far the least generated content during the awareness campaigns. Such results show that Twitter was appropriated as a broadcasting platform more than a discussion platform. Such results are consistent with earlier studies [16].

Celebrities were the least active during the events. Their few tweets, however, were responsible of approximately 21% of the generated retweets. This is also shown in their out-degree centrality results, where three celebrities were listed among the top 20 big players at the ranks 2, 12, and 13 on the list. Surprisingly, those three celebrities were retweeted more than some sponsoring organizations of the events, namely the International Agency for the Prevention of Blindness (IAPB) that sponsors the World Sight Day and the National Federation of the Blind that sponsors the White Cane Safety Day and

<table>
<thead>
<tr>
<th>Unique Users</th>
<th>Organizations</th>
<th>Celebrities</th>
<th>Individuals</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>1,337</td>
<td>17</td>
<td>3,542</td>
<td>4,896</td>
</tr>
<tr>
<td>Mean</td>
<td>1.53</td>
<td>0.14</td>
<td>4.37</td>
<td>3.26</td>
</tr>
<tr>
<td>SD</td>
<td>1.02</td>
<td>0.25</td>
<td>1.23</td>
<td>0.60</td>
</tr>
<tr>
<td>Percentage</td>
<td>55.3%</td>
<td>0.6%</td>
<td>44.1%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tweets</th>
<th>Count</th>
<th>Mean</th>
<th>SD</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizations</td>
<td>1,060</td>
<td>0.8</td>
<td>0.7</td>
<td>0.2</td>
</tr>
<tr>
<td>Celebrities</td>
<td>2.0</td>
<td>0.6</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Individuals</td>
<td>2.0</td>
<td>0.5</td>
<td>0.6</td>
<td>1.2</td>
</tr>
<tr>
<td>Percentage</td>
<td>55.3%</td>
<td>0.6%</td>
<td>44.1%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Retweets</th>
<th>Count</th>
<th>Mean</th>
<th>SD</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizations</td>
<td>867</td>
<td>0.7</td>
<td>0.5</td>
<td>0.9</td>
</tr>
<tr>
<td>Celebrities</td>
<td>1.5</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Individuals</td>
<td>0.4</td>
<td>0.00</td>
<td>0.00</td>
<td>0.1</td>
</tr>
<tr>
<td>Percentage</td>
<td>52.9%</td>
<td>0.00%</td>
<td>47.1%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Replies</th>
<th>Count</th>
<th>Mean</th>
<th>SD</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizations</td>
<td>18</td>
<td>0.01</td>
<td>0.00</td>
<td>0.006</td>
</tr>
<tr>
<td>Celebrities</td>
<td>0.7</td>
<td>0.4</td>
<td>0.6</td>
<td>1.2</td>
</tr>
<tr>
<td>Individuals</td>
<td>0.4</td>
<td>0.00</td>
<td>0.00</td>
<td>0.1</td>
</tr>
<tr>
<td>Percentage</td>
<td>52.9%</td>
<td>0.00%</td>
<td>47.1%</td>
<td></td>
</tr>
</tbody>
</table>
TABLE II: Most central accounts

<table>
<thead>
<tr>
<th>Screen name</th>
<th>Out-degree</th>
<th>Centrality</th>
<th>Bio</th>
<th>Followers</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHO</td>
<td>733</td>
<td>1.000</td>
<td>Official Twitter account of the World Health Organization, the United Nations' health agency</td>
<td>2,974,661</td>
<td>Organization</td>
</tr>
<tr>
<td>James Maslow</td>
<td>497</td>
<td>0.678</td>
<td>I work hard to never have to work. Snapchat: RealJamesMaslow IG: JamesMaslow For Inquires: <a href="mailto:asst@jamesmaslow.com">asst@jamesmaslow.com</a></td>
<td>3,132,685</td>
<td>Celebrity</td>
</tr>
<tr>
<td>Valerie Jarrett</td>
<td>346</td>
<td>0.472</td>
<td>Senior Advisor to President Barack Obama. Chair of the White House Council on Women and Girls. <a href="http://wh.gov/privacy">http://wh.gov/privacy</a></td>
<td>175,834</td>
<td>Organization</td>
</tr>
<tr>
<td>Liverpool FC</td>
<td>215</td>
<td>0.293</td>
<td>Official worldwide account of Liverpool FC, England’s most successful club with 41 major honours #LFC</td>
<td>6,292,094</td>
<td>Organization</td>
</tr>
<tr>
<td>RNIB</td>
<td>123</td>
<td>0.168</td>
<td>We’re RNIB. If you’re affected by sight loss, we’re here for you.</td>
<td>32,130</td>
<td>Organization</td>
</tr>
<tr>
<td>DG Foundation</td>
<td>121</td>
<td>0.165</td>
<td>DG Foundation fosters lifetime enrichment for members, promotes Service for Sight, and partners with the Fraternity to ensure the future of our sisterhood.</td>
<td>3,688</td>
<td>Organization</td>
</tr>
<tr>
<td>Ministry of Health</td>
<td>107</td>
<td>0.146</td>
<td>This is the official twitter account of Ministry of Health &amp; Family Welfare, Government of India</td>
<td>379,009</td>
<td>Organization</td>
</tr>
<tr>
<td>Standard Chartered</td>
<td>76</td>
<td>0.104</td>
<td>We’re a leading international bank. Follow us for news and views from across the bank. Please direct customer service queries to @StanChartHelp.</td>
<td>39,542</td>
<td>Organization</td>
</tr>
<tr>
<td>Seaofchangefilm</td>
<td>76</td>
<td>0.104</td>
<td>Hard hitting documentary showing impact of shared space road design on blind people in UK.</td>
<td>2,337</td>
<td>Organization</td>
</tr>
<tr>
<td>Qatar Airways</td>
<td>70</td>
<td>0.095</td>
<td>Official account of Qatar Airways. Follow us for others, news, and careers. For Customer Care, please visit <a href="http://qatarairways.com/tell-us">http://qatarairways.com/tell-us</a></td>
<td>1,071,299</td>
<td>Organization</td>
</tr>
<tr>
<td>Delta Gamma</td>
<td>43</td>
<td>0.059</td>
<td>This is the official Twitter account of the #DeltaGamma Fraternity. #DoGood.</td>
<td>23,837</td>
<td>Organization</td>
</tr>
<tr>
<td>Julie Chen</td>
<td>38</td>
<td>0.052</td>
<td>Host/Moderator of @TheTalkCBS, Host of @CBSBigBrother &amp; @BBOverTheTop, devoted wife, mom &amp; yogi! <a href="http://www.thetalk.com">http://www.thetalk.com</a> <a href="http://www.cbs.com/BigBrother">http://www.cbs.com/BigBrother</a></td>
<td>349,981</td>
<td>Celebrity</td>
</tr>
<tr>
<td>IAPB</td>
<td>35</td>
<td>0.1</td>
<td>The International Agency for the Prevention of Blindness (IAPB) is a membership organisation leading international efforts in blindness prevention.</td>
<td>4,593</td>
<td>Organization</td>
</tr>
<tr>
<td>VISION 2020 UK</td>
<td>34</td>
<td>0.046</td>
<td>VISION 2020 UK leads collaboration between organisations in the eye health and sight loss sector. Tweets by Matt Broom &amp; Niall Ryan</td>
<td>6,026</td>
<td>Organization</td>
</tr>
<tr>
<td>John G. Pare Jr.</td>
<td>34</td>
<td>0.046</td>
<td>It’s time to really change the world! Lets work together to erase low expectations, lack of opportunity, and discrimination experienced by blind people.</td>
<td>450</td>
<td>Individual</td>
</tr>
<tr>
<td>BlindNewWorld</td>
<td>33</td>
<td>0.045</td>
<td>#BlindNewWorld is a #blind awareness campaign to demystify blindness and break down the barriers to inclusion. Change the way you see. #BNW</td>
<td>3,850</td>
<td>Organization</td>
</tr>
<tr>
<td>NFB</td>
<td>23</td>
<td>0.031</td>
<td>News and information from the National Federation of the Blind</td>
<td>8,684</td>
<td>Organization</td>
</tr>
<tr>
<td>Accessible India</td>
<td>25</td>
<td>0.034</td>
<td>Official account of #AccessibleIndia Campaign, a nationwide flagship campaign for achieving universal accessibility, Ministry of @MSJEIOI</td>
<td>7,765</td>
<td>Organization</td>
</tr>
<tr>
<td>Prasar Bharati</td>
<td>24</td>
<td>0.033</td>
<td>Official account of Prasar Bharati, India’s Public Service Broadcaster. Prasar Bharati archives are available online at <a href="http://prasarbharatiarchieves.co.in">http://prasarbharatiarchieves.co.in</a></td>
<td>63,165</td>
<td>Organization</td>
</tr>
</tbody>
</table>

The table also presents a short bio of the user, the number of followers and account type.

More than half of the retweets were ones generated by the top 10 accounts who constitute around 2% of the retweeted users. Of those top 10, 9 were organizations while only 1 was a celebrity with the World Health Organization being the most retweeted account (733 retweets). We found it surprising that 9 out of the 10 big accounts generated very few tweets that ranged from 1 to 5 tweets only. We consider this as an evidence of how important the selection of information dissemination channels are during awareness campaigns. From a national perspective, it was interesting to observe the presence of 3 big players from India. This could be explained by a reported fact that India has the highest blind population in the world [27], resulting in a response from the Indian government that launched the National Programme for Control of Blindness [28].

Out of the top 20 accounts, there were 10 users who are neither dedicated to the issues of blindness nor to health. Examples are James Maslow, who is an actor, and Liverpool football club. We believe that this has contributed to the

the Meet-The-Blind Month. This emphasizes the influence of celebrities in spreading the message in social media platforms.

B. Identifying Major Players (Q2)

We define major players as active Twitter users whose content was most frequently propagated (i.e., retweeted) by other users similar to [11]. To quantify this, the out degree centrality of each active user was calculated based on the retweet network constructed based on active users as nodes and retweets as edges. The centrality was normalized by the maximum degree \((C_{max} = 733)\) for the results to be comparable with other studies of different network size. The network contained a total of 3,965 nodes and 4,193 directed edges.

To show the major players, we listed top 20 users ranked according to their degree centrality (largest first) in Table [1].

Examples are James Maslow, who is an actor, and Liverpool football club. We believe that this has contributed to the
spread of the message to a more diverse audience whose population do not primarily engage in social media to know about contemporary blindness issues. This also signifies the importance of engaging others in dissemination of awareness information.

A graphical representation of the network is shown in Figure 1. In addition to visualizing users and flow of information, the size of user’s node was enlarged in accordance with their centrality. We also colored the retweet communities based on Blondel et al. community detection [29].

Approximately 98% of the retweeted users had less than 50 retweets while the rest of the retweeted content was distributed over the remaining 2% of the retweeted users. A high max-to-min ratio and a high right-skew on a linear scale are both symptoms of a scale-free network [30]. Figure 2 shows the plotted out-degree distribution. While the out-degree distribution of the retweeted users show both a high max-to-min ratio and a high right skew on a linear scale, it is not a straight line on a log-log scale. This indicated that this was not a Power Law distribution. Nonetheless, we believe that the high max-to-low ratio and the high right skewness of the distribution still carry the implication of a scale-free network that few nodes in the network work as hubs that have significantly more connections than the majority of the nodes. Such insight stresses more on the importance of being selective in choosing the appropriate information dissemination channels.

C. Topics Identification (Q3)

The expected outcome of topics identification is to arrive at a set of themes that can adequately represent the generated content. This can be achieved by either manual coding as in [17] or by using topic inference algorithms as in [16]. In our study, we chose to automate topic identification over manual coding for two reasons. First, manual coding is resource intensive as it requires both time and manpower. Second, scaling up a manual coding process to cover larger content is difficult since more resources, in terms of time and manpower, are needed as the size of the to-be-analyzed data grows, which is not always feasible [16]. Therefore, we used the Latent Dirichlet Allocation (LDA) [31] algorithm to automatically discover topics. The algorithm takes a corpus (i.e., a collection of tweets) as an input and generates a list of probable topics associated with the provided collection.

We used MALLET’s [32] implementation of the LDA algorithm due to its robustness and popularity. Tweets corresponding to each of the three user groups (i.e., organizations, Twitter celebrities, and individuals) were passed to the algorithm separately. This results in three sets of topics assigned to each user group, helping us to conduct a richer analysis. To reduce the data noise, the tweets were post-processed to remove the web URLs and the common English stop words. The analysis resulted in 6 common topics across user groups as follows. Table III shows the contribution of each user group per topic theme listed below.

1) Preventable blindness awareness includes tweets related to preventative health practices such as frequent eye exams, general eye health practices, and preventable/curable blindness diseases.
2) Event purpose awareness inform the public about the purpose of each awareness event. This also includes tweets that encourage the public to celebrate the observation of such events.
3) Donate to fight preventable blindness encourage the public to donate to organizations dedicated to fight preventable/curable blindness.
4) Visual impairments public awareness includes tweets directed to both the public and people with visual impairments. Tweets related to this theme can communicate statistics about people with visual impairments, accessibility issues, social misconceptions, assistance tips, and specific awareness directed to the visually impaired.
5) Activity driven awareness inform the public about local and global activities that are related to the awareness campaigns such as awareness walks.
6) Visually impaired heroes stories focus on informing the public about exemplar visually impaired figures such as visually impaired innovators and athletes.

None of the identified topics were unexpected as they matched the awareness objectives of most of the campaigns under analysis. The World Sight Day’s main objective is to attract the public’s attention to blindness and visual impairments...
from awareness, prevention and funding perspectives [6], which matches topics 1, 2, 3 and 4. The goals of the White Cane Safety Day is to educate the public about the visually impaired and celebrate their independence and abilities [7], which matches topics 2, 4, 5, and 6. The main objective of the Blindness Awareness Month is to educate the public about living without sight [4], which matches topics 2 and 4.

The objectives of the Meet-The-Blind Month is to conduct activities at local communities for them to meet their blind members [8]. We could not find a strong evidence of the existence of content that hints at activities related to this event. This could be due to the fact that there were very few tweets that were related to the event compared to the rest, which were around 1.4% of the total tweets in the data set.

The content analysis showed that, overall, there was a focus on spreading awareness information to the public about visual impairments more than any other topic. This was expected as this was the common topic across most of the awareness campaigns. User groups varied in with respect to the dominant topics of their generated content. Around 70% of the organizations’ content was related to topics of event purpose awareness and visual impairments public awareness (32.6% and 34.9%, respectively). We find this not surprising as it is natural that organizations, especially those whose mission is directly related to blindness, take the responsibility of awareness more than celebrities and individuals.

What we found surprising is that seeking donations was the least covered topic by organizations. This differs from the study by Nah and Saxton [33], where it was suggested that non-profit organizations are more inclined to use social media to seek donations from the public more than doing so from the government.

The content diversity of tweets sent by celebrities was the least consistent across the three user groups. Out of the 20 tweets sent by celebrities, 11 tweets (55.0%) were about seeking donations to fund blindness prevention research while relatively very low portion of the tweets was dedicated to spreading blindness awareness information. The content generated by individuals was the most consistent, having relatively higher focus of individuals on spreading awareness information and seeking donations than talking about awareness driven activities and sharing stories about visually impaired heroes.

### D. Information Reachability (Q4)

The goal behind quantifying information reachability is to measure the amount of information spread among active users (the user groups) during the campaign. Therefore, we define information reachability as the number of unique users who received a given tweet similar to TweetReach [34], the Twitter analytics tool.

We calculated the information reachability by multiplying the number of tweets relevant to our search criteria by the number of user’s followers [16]. The calculated impressions

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**TABLE III: A breakdown of tweet for each topic per user group**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Organizations count (%)</th>
<th>Celebrities count (%)</th>
<th>Individuals count (%)</th>
<th>Total count (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,994</td>
<td>20</td>
<td>4,179</td>
<td>6,143</td>
</tr>
<tr>
<td>topic 1</td>
<td>367 (18%)</td>
<td>5 (25.0%)</td>
<td>708 (16.9%)</td>
<td>1,080 (17.6%)</td>
</tr>
<tr>
<td>topic 2</td>
<td>634 (32.6%)</td>
<td>0 (0%)</td>
<td>663 (15.9%)</td>
<td>1,297 (21.1%)</td>
</tr>
<tr>
<td>topic 3</td>
<td>62 (3.2%)</td>
<td>11 (55.0%)</td>
<td>764 (18.3%)</td>
<td>837 (13.6%)</td>
</tr>
<tr>
<td>topic 4</td>
<td>678 (34.9%)</td>
<td>1 (5.0%)</td>
<td>1,478 (35.4%)</td>
<td>2,157 (35.1%)</td>
</tr>
<tr>
<td>topic 5</td>
<td>72 (3.7%)</td>
<td>0 (0%)</td>
<td>316 (7.6%)</td>
<td>388 (6.3%)</td>
</tr>
<tr>
<td>topic 6</td>
<td>131 (6.7%)</td>
<td>3 (15%)</td>
<td>250 (6.0%)</td>
<td>384 (6.3%)</td>
</tr>
</tbody>
</table>

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**TABLE IV: A breakdown of impressions per user group**

<table>
<thead>
<tr>
<th>User Group</th>
<th>Organizations</th>
<th>Celebrities</th>
<th>Individuals</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>1,337</td>
<td>17</td>
<td>3,542</td>
<td></td>
</tr>
<tr>
<td>Total Impressions</td>
<td>58,624,773</td>
<td>8,863,679</td>
<td>5,675,939</td>
<td>56,759,399</td>
</tr>
<tr>
<td>Mean Impressions</td>
<td>43,848</td>
<td>521,393</td>
<td>1,603</td>
<td>5,933</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>772,900</td>
<td>733,892</td>
<td>5,933</td>
<td></td>
</tr>
</tbody>
</table>

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for each user were grouped by user group. To show the mean impressions per user, the calculated impressions for each user group were divided by the size of the group. It is worth mentioning that such metric has its own implications on user importance that differ from those of the degree centrality.

While a user could have most of his or her tweets retweeted (and hence has a high out-degree centrality), this does not necessarily translate to a high content volume generated by that user. On the other hand, a user having a high followers-based centrality does not necessarily indicate how active this user is during a given event. Finally, a user whose generated content volume is high does not necessarily mean that the user’s content reaches a wide user base. Information reachability gives implications on both user’s generated content volume (i.e. activity) and the size of the user’s base.

Impressions were aggregated for each user group and are shown in Table [IV]. Organizations had total impressions that are an order of magnitude higher than celebrities and individuals. The mean impressions for celebrities, however, was an order of magnitude higher than both organizations and individuals.

In terms of impressions, organizations had the highest number of impressions, implying the highest reachability to Twitter users compared to celebrities and individuals user groups. This is not surprising as organizations generally had more followers than those of individuals and that they generated more content than celebrities. Celebrities generated far less content than organizations (20 by celebrities versus 1,945 by organizations), but their mean impression was an order of magnitude higher.

Given that impressions is a function of the number of tweets and the number of followers, this suggests that celebrities impressions (and hence reachability) would increase at a much higher rate than organizations as their tweets increase. In other word, one more tweet by a celebrity will reach a larger audience, on average, than a tweet by an organization. This is another evidence of how celebrities can be instrumental in information dissemination of a given campaign.

### E. Temporal Analysis (Q5)

The goal of this analysis is to observe the frequency of tweet activity over the chosen one week period. Such analysis would help us understand how consistent the content generation is throughout the one week period. To this end, we analyzed the temporal tweeting activities of each of event separately in addition to the total tweeting activity for all events combined. Such separation would allow us to have more granular analysis.

A daily distribution of the tweets for each event was constructed. Figure [5] summarizes the results. Results are tabulated for the World Sight Day, the White Cane Safety Day, the Blindness Awareness Month, and Meet the Blind Month.

Tweet activity was highest at the day of the event for both the World Sight Day (October 13th) and the national White Cane Safety Day (October 15th). Tweet activity showed a slow declination rate for the Blindness Awareness Month. The tweet trend of the Meet the Blind Month followed the trend
of the White Cane Safety Day, having its peak tweet activity at the 15th of October, the day on which the event is observed nationally. The highest tweet activity overall took place on October 13th, the day the coincides with the World Sight Day. The temporal tweeting activity of one-day events such as the World Sight Day was consistent with the observance of the event. The tweeting activity of such events was at its peak at the day of the event while it was noticeably lower before and after the day of the event. The activity decline rate of the World Sight Day was more steeper than that of the other one-day events. The tweeting activity of the Blindness Awareness Month was generally declining across the 7 days of the captured data. The other one-month event, Meet the Blind Month, had a tweeting activity that was consistent with that of the White Cane Safety Day, having around 42% of its related tweets during the day of the White Cane Safety Day, showing an endorsement of the event.

IV. DISCUSSION

We collected a total of 6,143 tweets that were related to four visual impairments campaigns: the World Sight Day, the White Cane Safety Day, the Blindness Awareness Month, and the Meet-The-Blind Awareness Month. In this section, we discuss the implications of our findings and limitations of our analysis.

A. Implications

The results of this study showed the different roles that user groups play in the process of information dissemination in social media. Organizations showed an active role in generating original content. Celebrities had the highest information reachability compared to organizations and individuals. On the other hand, individuals were mostly information propagators. We believe that strictly assigning roles to user groups is an oversimplification of the information dissemination process. Rather, we suggest keeping in mind what each user group is best at as we believe that this would give more input to awareness campaign managers, assisting them to design more effective communication strategies.

With this distinction of roles, organizations can focus more on crafting effective awareness messages and utilize celebrities, who are capable of reaching a wider and more diverse audience, to spread these messages. Individuals, who form the majority of the active user base, will take it from there to further propagate the messages. Such collaboration between different users have already been suggested by Thackeray et al. [16], who encouraged the collaboration between organizations and celebrities for an effective information spread; and also by Chung [11] who suggested the collaboration between campaign sponsors and both media and non-profit organizations to spread the awareness messages.

This optimization effort can be also framed as an Information Cascade Maximization problem [35] that uses Twitter followers network as the observed network with the assumption that all followers are going to be activated by receiving a tweet from the user they follow. We believe that doing so will increase the probability of spreading the awareness information to the largest audience possible.

B. Limitations

We acknowledge that our study had several limitations. Collected replies were matched with the keywords used in the search criteria. Optimally, replies should have been collected by gathering all replies associated with a tweet that matched the used search criteria. This is because users usually don’t use any event hashtags when replying to a tweet. This limitation may have resulted in collecting only a few replies.

We used an automated decision tree to classify the users in our study. We cleaned obvious false positives manually, but some users may have been still classified incorrectly, which may have affected the results that build on users classification.

To identify major players, we used out-degree centrality of the retweet network that we built. We specifically chose out-degree centrality to be comparable with similar studies such as [11] who also used out-degree centrality. Other centrality measures, such as PageRank [36] may have shown better centrality results by highlighting those who are highly retweeted by users who are also highly retweeted.

Content analysis was done against the content generated by each user group to learn about the tweeting interests of each user group. Further insights could have been derived if another content analysis was done against the content related to each event.

Finally, the results and the insights of this study are only based on a one-week sample taken in October 2016 and therefore might not be representative of overall campaigns that could span the whole year. Also data from prior years may reveal different trends.
V. CONCLUSION

To our knowledge, this is the first study that analyzed the use of social media platforms to disseminate information in disabilities-related awareness campaigns. The study was concerned with four visual impairments campaigns during the month of October: the World Sight Day, the White Cane Safety Day, the Blindness Awareness Month, and the Meet the Blind Month. The study attempted to answer five questions that are concerned with the characteristics of active users, the major information disseminators, the common communication topics, the reachability of information, and the temporal behavior of the disseminated information of each campaign.

It was found that each user group has a distinct capability based on their activities during the events. In terms of information spreading capabilities, organizations were best at generating the awareness content, celebrities were capable of reaching the largest audience on average, and individuals were the most information propagators among the user groups both in total and on average.

In terms of the topics of their generated content, organizations were more inclined to tweet about the purpose of the awareness campaign in addition to spreading general awareness about visual impairments. Celebrities were focused on seeking donations from the public to support the fight against curable blindness. Finally, most the individuals' tweets were about general visual impairments awareness.

We found that there are very few users who act like hubs that spread most of the information. With respect to the temporal tweeting activity, we found that the tweeting activity was generally affected by the observance of one-day events, namely the World Sight Day and White Cane Safety Day.

For campaign managers to have effective communication strategies with predictable outcomes, a structured approach to the information diffusion development process should leverage the unique characteristics of each user group and consider the outcomes of this study.

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